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50X1-HUM

AIRCRAFT
DESCRIPTION
BOOK No 1

50X1-HUM

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The Aircraft Description consists of three books:

Book I. - General. Technical data. Aerodynamics and performance. Weight and balance data. Transport equipment. Armament.

Book II. - Aircraft design. Power plant. Hydraulic system. Cabin air system and air-heat de-icing system. Ground equipment.

Book III. - Instrument equipment. Oxygen equipment. Photographic equipment. Radio equipment. Aircraft bonding. Electrical equipment.

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S E C T I O N I

GENERAL

The AN-12 transport (Figs. 1, 2, 3, 4, and 5), powered by four turboprop engines, is designed to carry various bulky loads of total weight up to 16 t.

The aircraft crew consists of six members: two pilots, a flight engineer, navigator and radio operator accommodated in the forward pressurized cabin, and a gunner – in the tail pressurized cabin.

The aircraft is a cantilever monoplane of all-metal construction with high-set wing and single-fin tail unit.

A pressurized compartment for the aircraft crew and cargo attendants is located in the fuselage nose, and the gunner's pressurized cabin is in the fuselage tail section.

In the fuselage centre section there is a spacious cargo compartment that can accommodate various bulky loads.

The aircraft is loaded or unloaded through the cargo door measuring 7.67 x 2.95 m.

Provision is made for opening the cargo door in flight.

The aircraft wing is cantilever, of high aspect ratio, torsion-box type, two-spar construction.

The aircraft tail unit is cantilever, with one fin and no dihedral angle. The fin and stabilizer are of two-spar construction with stressed skin. The rudder has a trim tab and a spring-loaded balance tab. The elevator is made in two separate parts, each of them having a trim tab.

The retractable landing gear has a steerable nose wheel whose control is interconnected with the rudder and brakes of the aircraft running at ground speed even on slippery airfield ground covered with ice.

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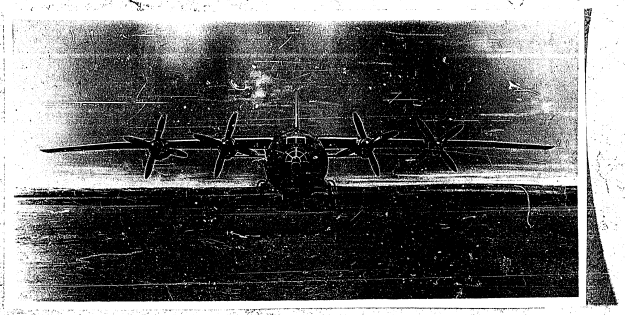

Fig. 1. AN-12 Aircraft, front view.

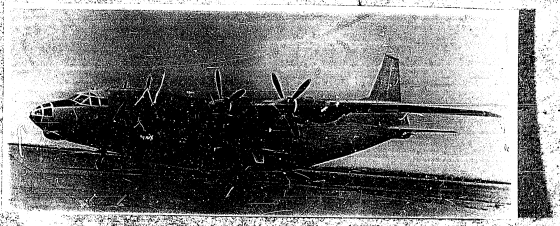

Fig. 2. AN-12 Aircraft, 3/4 front view.

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Fig.3 JJ-12 Aircraft, side view.

Fig. 4. JJ-12 Aircraft, 3/4 front view.

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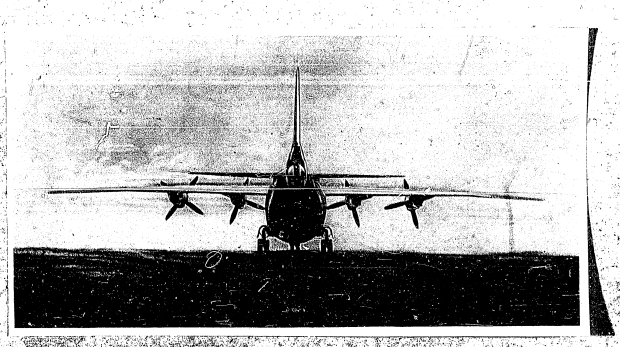

Fig. 5. AH-12 Aircraft, rear view.

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Two four-wheeled bogies of the main landing gear ensure safe aircraft taxying in case of a wheel failure and enable the aircraft to run on soft, sodded, shingly, sandy, snow - or ice-covered ground of an airfield.

The landing gear is retracted and extended by means of a dual duplicated hydraulic system. The wheels of the bogies are fitted with hydraulic brakes with an automatic anti-skid control preventing the wheels from skidding when braked.

The aircraft has dual control from the stations of both the pilot and co-pilot. Elevator, ailerons and rudder control is effected through a rod-operated linkage. The trim tabs and balance tab are used to counteract the hinge moments of the control surfaces.

The aircraft is equipped with an AP-28M autopilot.

The aircraft powerplant consists of four 4000 e.h.p. AI-20 turboprop engines driving 4.5 m. diameter four-bladed AV-68M propellers. The engines are mounted in nacelles located under the wing. All the four nacelles are structurally similar which permits them to be interchangeable. The AI-12 aircraft engines and propellers are equipped with an automatic propeller feathering system for the case of engine failure at all ratings - from the take-off to the 0.7 nominal rating. The aircraft is equipped with a fire extinguishing system to fight engine fire, fires in the nacelles and wing cells where the fuel tanks are installed.

The aircraft cabin air system ensures conditions in the crew and cargo attendants' compartments required for high-altitude operations.

The air conditioning system joins the ventilation, heating and cabin pressurization system in a single automatic system.

The oxygen equipment installed on the aircraft is a crew emergency oxygen system and is also used when people are carried in the cargo compartment. The modern liquid oxygen supply system used in the

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aircraft ensures great gasious oxygen supply at a moderate weight and increased safety.

The de-icing equipment used in the aircraft enables it to operate in severe icing conditions. For this purpose hot air from the engines and electrical heating system are employed.

The flight and navigational equipment enables the crew to fly day and night at all altitudes in any weather conditions.

The aircraft radio equipment allows the crew to effect two-way long-range communication with the ground radio stations, other aircraft of a formation and with the point of departure; in addition it provides intercommunication between the crew members, it is used to make an instrument landing controlled by ground radio stations, determine true flight altitude and solve other navigational problems.

The electric power consumers are supplied with 28.5 V.D.C., 115 V 400 c.p.s. single-phase A.C. and 36 V, 400c.p.s. three-phase A.C. Eight СТГ-12ТМ starter-generators installed on the engines and seven 12САМ-28 batteries in the wheel fairing are used as D.C. power supply sources. Four СГО-12 A.C.generators installed on the engines are sources of 115 V, 400c.p.s. A.C. power supply.

Two ПТ-500Ц inverters and one ПАГ-1ФП inverter are sources of 36 V, 400 c.p.s. three-phase A.C. power supply. The 115 volt ,400 c.p.s D.C.and A.C.circuits are single-wire, i.e. the aircraft structure serves as common ground.

Ten 12САМ-28 batteries are provided in the rear baggage compartment to ensure reliable engine starting from the aircraft power supply sources.

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SECTION II

AIRCRAFT TECHNICAL DATA

Nos.	Description	Dimension or type	Remarks
	I. GENERAL DATA		
1.	Length	33.1 m.	
2.	Span	38.0 m.	
3.	Height on the ground	10.50 m.	
4.	Fuselage clearance with landing gear statically compressed	0.73 m.	
5.	Wing landing angle with main L.G. shock-struts fully compressed	12°30'	
6.	Cargo floor threshold height above the ground	1.414 m.	
	2. FUSELAGE		
1.	Length	33.1 m.	Overall length with tail turret
2.	Height	4.50m	Overall height with centre wing
3.	Width	4.55 m.	Overall width with L.G. fairings included
4.	Diameter of fuselage in its cylindrical portion between frames Nos.17 and 33	4.10 m	
5.	Cargo compartment interior dimensions:		

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Nos.	Description	Dimension or type	Remarks
	a) volume	123.30 m^3	
	b) length	13.50 m.	
	c) width (on the floor):		
	- between frames Nos.13-25 and 30-43	3.50 m.	
	- between frames Nos.25-30	3.0 m.	
	d) height		
	- between frames Nos.13 and 25	2.50 m.	
	- between frames Nos.25 and 30	2.40 m.	
	- between frames Nos.30 and 43	2.60 m.	
6.	Cargo compartment dimensions:		
	- length	7.67 m.	
	- width at frame No.43	2.95 m.	
	- width at frame No.51	2.91 m.	
	- width at frame No.59	2.36 m.	
7.	Volumes of under-floor baggage compartments:		
	- forward	11.4 m^3	
	- rear	5.3 m^3	
8.	Entry door size	800x1480 mm	
9.	Sizes of baggage compartment doors		
	- forward	1280x760 mm.	
	- rear	780x670 mm.	

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Nos.	Description	Dimension or type	Remarks
	3. WING		
1.	Span	38.0 m.	
2.	Area (wing centre section included)	121.73 m^2	
3.	Mean aerodynamic chord	3.452 m.	
4.	Wing aspect ratio	11.85	
5.	Wing taper ratio	2.80	
6.	Wing sweepback at 25% chord line	6°30'	
7.	Wing dihedral angle (between planes of the inner wing chords and wing centre section)	1.0°	
8.	Wing setting angle relative to the fuselage centre line	+4°	
9.	Wing dihedral angle(between planes of inner wing and outer wing chords)	-3°	
10.	Ailerons:		
	- length	5.90 m.	
11.	Flaps (double-slotted,extension):		
	- length	10.96 m.	
	4. TAIL PLANE		
1.	Span	12.196 m.	
2.	Tail plane area including under-fuselage portion	26.95 m^2	22.2% wing area
3.	Stabilizer area including under-fuselage portion	19.85 m^2	73.6% tail plane area
4.	Elevator area	7.10 m^2	26.4% tail plane area.

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Nos.	Description	Dimension or type	Remarks
5.	Tail plane M.A.C.	2.39 m.	
6.	Tail plane chords :		
	- in the plane of aircraft symmetry	3.284 m.	
	- tip	1.1465 m.	
7.	Tail plane aspect ratio	5.5	
8.	Tail plane taper ratio	2.82	
9.	Tail plane sweepback at 25% chord line	9°56'	
10.	Tail plane dihedral angle	0°	
11.	Angle of stabilizer setting relative to wing chord	4°0'	
12.	Elevator trim tabs area	0.78 m²	11.0% elevator area.
13.	Elevator balance area (per cent of elevator area)	29.00	
	.5. VERTICAL TAIL		
1.	Vertical tail height measured from fuselage top	5.83 m.	
2.	Height of vertical tail detachable part	4.52 m.	
3.	Vertical tail area (area of trapezoidal portion without dorsal fin)	21.534 m²	17.7% wing area
4.	Fin area	14.99 m²	69.6% vertical tail area

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Nos.	Description	Dimension or type	Remarks
5.	Rudder area	6.544 m^2	30.4% vertical tail area
6.	Vertical tail M.A.C.	4.05 m.	
7.	Chords of vertical tail (trapezoidal portion):		
	- at fuselage top level	5.66 m.	
	- at root (at joint)	4.78 m.	
	- at tip	1.73 m.	
9.	Vertical tail aspect ratio (trapezoidal portion without dorsal fin)	1.58 m.	
10.	Vertical fin taper ratio (trapezoidal portion without dorsal fin)	0.27	
11.	Vertical fin sweepback at 25% chord line	$15^{o}5'$	
12.	Rudder trim tab area	0.268 m^2	4.1% rudder area
	6. LANDING GEAR		
1.	Wheel track:		
	- at outboard wheels	5.412 m.	
	- at shock struts axes	4.92 m.	
2.	Minimum radius of turn when taxying	13.75 m.	

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7. AM-20 ENGINE PRINCIPAL PERFORMANCE

Nos.	Description	Value
1.	Engine R.P.M.:	
	a) operating ratings	12300±90 r.p.m.
	b) idle rating	10000±200 r.p.m.
2.	Maximum rating:	
	a) equivalent power (H=0, V=0 m/sec. P=760 mm.Hg. t^{o}=+15°C)	4000 e.h.p.
	b) specific fuel consumption for equivalent power (H=0, V=0 m/sec., P=760 mm.Hg., t^{o}=+15°C)	0.260 kg/e.h.p./hr.
	c) equivalent power (H=8000 m.; V=200 m/sec.	3250 e.h.p.
	d) specific fuel consumption (H=8000 m.; V=200 m/sec)	0.205 kg/e.h.p./hr.
3.	Normal rating:	
	a) equivalent power (H=0; V=0 m./sec.; P=760 mm.Hg, t^{o}=15°C)	3400 e.h.p.
	b)specific fuel consumption (H=0; V=0 m/sec.; P=760 mm.Hg, t^{o}=15°C)	0.280 kg/e.h.p./hr.
	c) equivalent power (H=8000 m.; V=175 m/sec.)	2600 e.h.p.
	d) specific fuel consumption (H=8000 m.; V=175 m/sec)	0.206 kg/e.h.p./hr.
4.	Cruising rating at 0.7 nominal:	
	a) equivalent power	2025 e.h.p.

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7. AM-20 ENGINE PRINCIPAL PERFORMANCE

Nos.	Description	Value
1.	Engine R.P.M.:	
	a) operating ratings	12300±90 r.p.m.
	b) idle rating	10000±200 r.p.m.
2.	Maximum rating:	
	a) equivalent power (H=0, V=0 m/sec. P=760 mm.Hg. t^{o}=+15°C)	4000 e.h.p.
	b) specific fuel consumption for equivalent power (H=0, V=0 m/sec., P=760 mm.Hg., t^{o}=+15°C)	0.260 kg/e.h.p./hr.
	c) equivalent power (H=8000 m.; V=200 m/sec.	3250 e.h.p.
	d) specific fuel consumption (H=8000 m.; V=200 m/sec)	0.205 kg/e.h.p./hr.
3.	Normal rating:	
	a) equivalent power (H=0; V=0 m./sec.; P=760 mm.Hg, t^{o}=15°C)	3400 e.h.p.
	b)specific fuel consumption (H=0; V=0 m/sec.; P=760 mm.Hg, t^{o}=15°C)	0.280 kg/e.h.p./hr.
	c) equivalent power (H=8000 m.; V=175 m/sec.)	2600 e.h.p.
	d) specific fuel consumption (H=8000 m.; V=175 m/sec)	0.206 kg/e.h.p./hr.
4.	Cruising rating at 0.7 nominal:	
	a) equivalent power	2025 e.h.p.

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Nos.	Description	Value
	b) specific fuel consumption	0.216 kg/e.h.p./hr.
5.	Permissible time of continuous engine operation:	
	at take-off rating	15 min. (not more than 4% eng. service life)
	at normal rating	unlimited within 22% eng. service life.
	at cruising rating	unlimited
	at idle rating	30 min.
6.	Acceleration	Not more than 15 sec.
7.	Fuel grade - kerosene	TC-1, T-1, T-2
8.	Oil grade	Mixture of 75% transformer oil and 25% MK-22 or MC-20 oil, by volume.
9.	Oil consumption	Not more than 1.5 kg./hr.
10.	Engine dimensions:	
	- length	3095 mm.
	- width	893 mm.
	- height	1106 mm.
11.	Engine dry weight	1050 kg.

8. AV-20 ENGINE RATING VERSUS FUEL CONTROL LEVER POSITION INDICATOR READING (in degrees)

Engine rating	Fuel control lever position, deg.	Equivalent power (e.h.p.)
Take-off	98 to 105	4000
Normal	84 ± 2	3400
0.8 normal	72 ± 2	2810
0.7 normal	61 ± 2	2380
0.6 normal	50 ± 2	2040
0.4 normal	35 ± 2	1360
0.2 normal	19 ± 2	680

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9. AB-68M PROPELLER DATA

1. Type L.H. rotation tractor, feathering, constant-speed propeller.
2. Diameter - 4.5 m.
3. Number of blades - 4
4. Model of constant-speed governor - P-68M
5. Blade pitch (at 1.6 m. radius)
   a) angle providing minimum drag to rotation (starting angle) ..... 0°
   b) flight-fine-pitch stop angle ..... 12°
   c) feathering angle ..... 83°
6. Blade pitch range ..... 83°

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S E C T I O N III

AIRCRAFT AERODYNAMICS AND PERFORMANCE

I. AERODYNAMIC DESIGN

The aircraft has good stability and controllability characteristics over the entire speed and C.G. position range.

To decrease the control forces, the rudder, elevator and ailerons are aerodynamically compensated. In addition the rudder is fitted with a spring balance tab mechanically linked to the rudder; the balance tab deflection angle depends on the force applied to the rudder pedals (is set in operation with a force on the pedals more than 15 kg.).

The elevator and rudder are fitted with trim tabs, and the ailerons - with trim-balance tabs by which the aircraft can be trimmed and the control forces removed at any flight conditions including flight with two inoperative engines located on the same side.

To ensure better flying safety the aircraft has special equipment that enables it to continue flying in emergency conditions.

The aircraft is equipped with automatic and manual propeller feathering system.

The aircraft can continue take-off and flying with one engine out. With two engines failed the aircraft can fly level at an altitude up to 5000 m.

If a safe landing with two engines running cannot be made, a missed-approach procedure can be taken.

Landing with two feathered propellers located on the same side presents no difficulty.

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II. PERFORMANCE

I. MAXIMUM AND MINIMUM FLYING SPEEDS

Given in Table 1 are maximum speeds and Mach-numbers versus altitudes; the values are obtained during operation at the maximum (100° indicated by the fuel control lever position indicator) and normal (84° indicated by the fuel control lever position indicator) ratings with the four engines operative and with three engines running at normal rating and with the average flying weight of 49,000 kg.

Table 1.

H st. (m)	$V_{max.st.}$ (km./hr.)			M st.		
	4 engines		3 engines	4 engines		3 engines
	100°	84°	84°	100°	84°	84°
	fuel control lever position indicator readings			fuel control lever position indicator readings		
0	520 x)	520 x)	-	0.424	0.424	-
2000	574 x)	574 x)	-	0.481	0.481	-
4000	637 x)	632	557	0.547	0.542	0.479
6000	679	654	564	0.596	0.574	0.496
8000	683	658	566	0.616	0.594	0.512
10000	649	625	-	0.595	0.580	-

Fig.6 shows curves of maximum speeds versus altitudes and curves of speeds limitations versus altitudes in standard conditions.

x) Speed limitation depending on dynamic pressure is as follows: q_{max}=1300 kg./m^2; $V_{ind.}$=520 km./hr.

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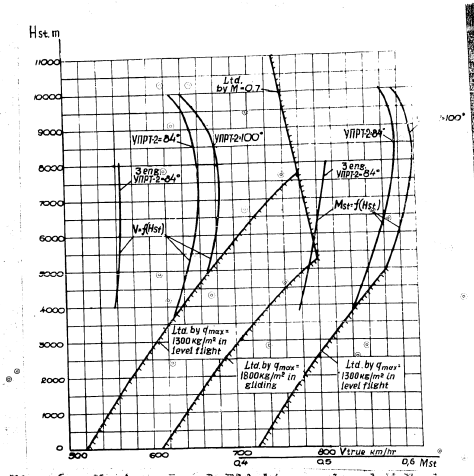

Fig. 6. Maximum Level-Flight speedsand M-Numbers Versus

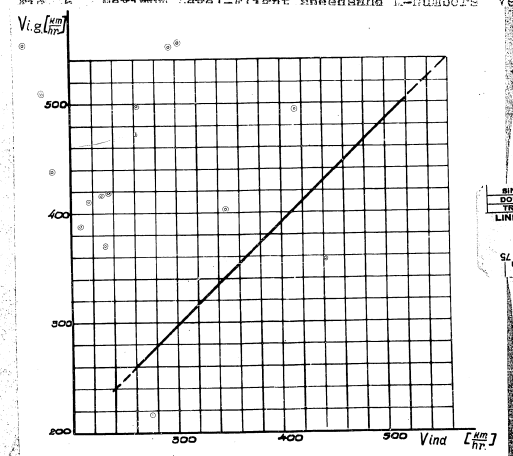

Fig. 7. Pitot Tube Correction Chart

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Table 2 gives values of minimum permissible speeds and stalling speeds at different angles of flap setting.

Table 2.

No.	Engine rating, deg. by fuel con. lever pos. ind.	Flight alti-tude, m.	L.G.	Flap setting, deg.	Flying wt, kg.	Min. permissible speed (I.A.S.), km/hr.	Stalling speed (I.A.S.) km/hr. x)
1	20	5000-6000	Up	0	49000-50000	235-245	200-210
2	20	7500-8500	Up	0	49000-50000	250-260	220-230
3	20	5500	Down	25	47600-48900	175-180	160-165
4	20	5000	Down	35	47500-48900	160-165	145-150

x) At engine normal rating stalling does not occur at these speeds (i.e. the stalling speed at α_f =84° by fuel control lever position indicator is lower than indicated in the table).

Pitot tube correction chart is given in Fig.7.

2. AIRCRAFT RATE OF CLIMB AND CEILING

Aircraft rate-of-climb and ceiling data for take-off weights of 51000 kg. and 54000 kg. with four or three engines running at normal rating are given in Table 3.

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Table 3.

H_{st} / m	V_y, m./sec.			$t_{st.}$, min.			$V_{ind.}$, km./hr.		
	4 engines		3 engines x)	4 engines	3 engines x)		4 engines		3 engines x)
	54 t.	51 t.	51 t.	54 t.	51 t.	51 t.	54 t.	51 t.	51 t.
0	9.6	11.1	6.4	0	0	0.	350		340
2000	8.9	10.3	5.6	3.6	3.1	5.6	350		340
4000	8.2	9.5	4.8	7.5	6.6	12.0	350		340
6000	6.5	7.7	3.5	12.1	10.3	20.1	350		330
8000	4.3	5.5	1.8	18.2	15.4	33.0	330		310
9000	2.6	3.7	0.5 xx)	24.5	20.0	54.0	316		296
10000	1.5	2.6	-	30.4	23.8	-	310		-
10500	0.9 xx)	1.8	-	38.6	27.4	-	305		-
11100	-	0.5 xx)	-	-	36.4	-	298		-

x) The propeller of the inoperative engine is feathered.
xx) Service ceiling.

Shown in Figs. 8 and 9 are curves of vertical speed and climb time required to attain an altitude up to service ceilings with the flying weights of 51000 kg. and 54000 kg. and four or three engines running at normal rating (84° by fuel control lever position indicator).

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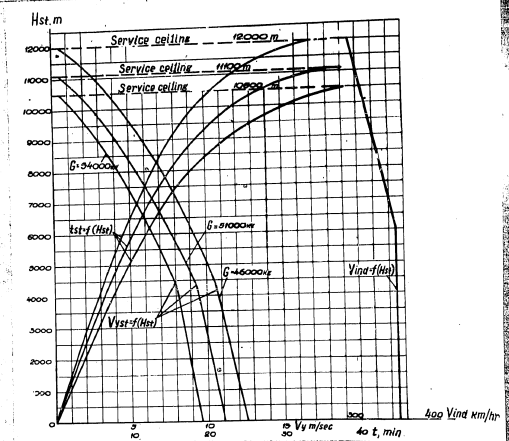

Fig.8. Maximum Vertical Speeds, Climb Time and Speed Versus Altitudes in Standard Conditions at Normal Engine Rating.

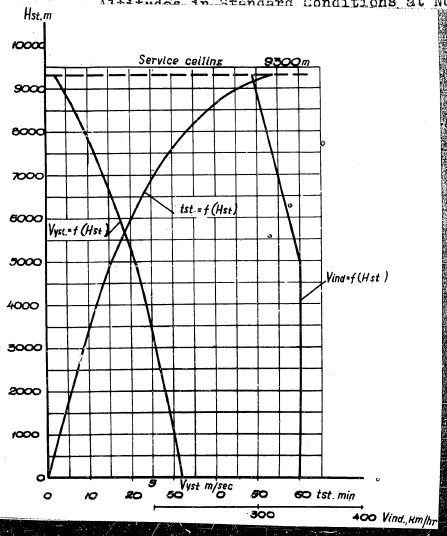

Fig.9. Maximum-Rate of Climb Versus Altitudes in Standard Conditions with Three Engines Running at Normal Rating.

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3. FUEL CONSUMPTION AND FLIGHT RANGE

Fig.10 shows relative fuel consumption per kilometer versus Mach numbers for different flying weights.

A reduced weight $G_{red.} = \frac{P_o}{P_H} \cdot G_{aircr.}$, where

P_o=760 mm.Hg., P_H - pressure at a given flying altitude,

$G_{aircr.}$ - aircraft flying weight in tons;

$\bar{q}$ ($\frac{\text{kilogramm}}{\text{ton·kilometer}}$) - relative fuel consumption per kilometer.

Fuel consumption in kg./km. is determined by the formula

$q = \bar{q} \cdot G_{aircr.}$, where $\bar{q}$ is taken from Fig.10.

The optimum flight range corresponds to the reduced weight of 160-185 t (H=10000 m) and M=0.53 (V_{true}=575 km/hr.); the relative fuel consumption per hour being 0.057 kg./t,km.

The fuel consumption rapidly increases with decrease in flight altitude and the maximum range decreases.

Figs. 11,12 and 13 and Tables 4, 5 and 6 illustrate maximum flight ranges at altitudes of 10000, 8000 and 4000 m. versus cargo and fuel weights.

The following data are given in Figs. 14, 15 and 16: fuel consumption, level-flight track length, climb and descend time versus the aircraft weight.

Climb is performed at the engine normal rating (24° by fuel control lever position indicator), and glide is executed - at idle rating (20° by fuel control lever position indicator).

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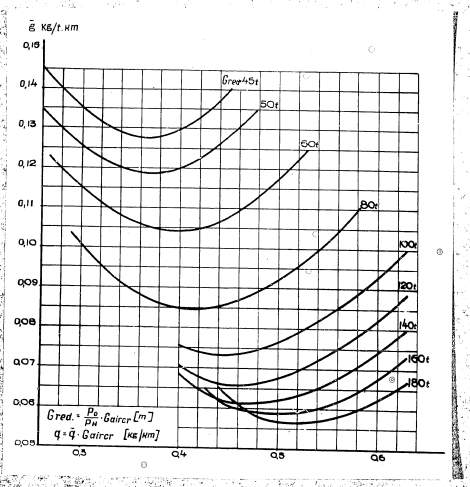

Fig.10. Relative Fuel Consumption per Kilometer Versus Mach-numbers.

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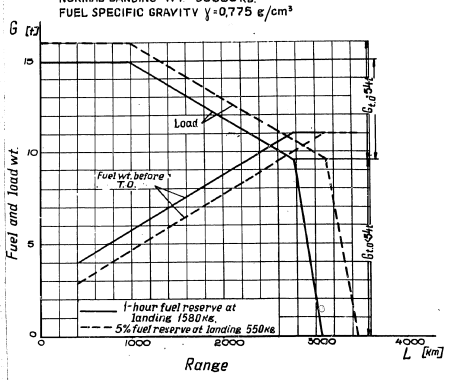
FLIGHT ALTITUDE 8000m.
BEST FLIGHT SPEED 540 km/hr.
EMPTY AIRCRAFT WT. 32350 kg.
NORMAL LANDING WT. 50000 kg.
FUEL SPECIFIC GRAVITY γ=0,775 g/cm³



NOTE: 1. FOR ENGINE STARTING RUNNING AND AIRCRAFT TAXYING THE AIRCRAFT IS FUELLED 500 kg. GREATER THAN INDICATED BY CHART.
2. FUEL CONSUMPT. IN CIRCLING FLIGHT - 280 kg.
3. UNCONSUMED FUEL - 105 kg.
4. MAXIMUM TOTAL WEIGHT OF FUEL AND LOAD - 20560 kg.

Fig. 11. Maximum Flight Range at Altitude of 10000 m. and Flying Speed of 575 km./hr. Versus Cargo and Fuel Weight before Take-Off.

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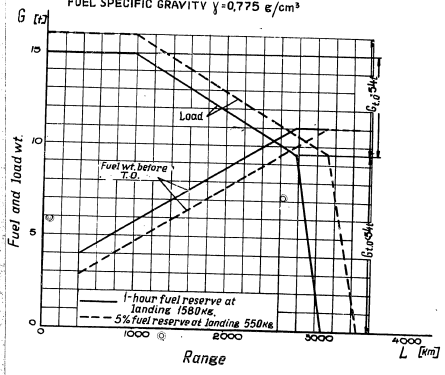

NOTE: 1. FOR ENGINE STARTING RUNNING AND AIRCRAFT TAXYING THE AIRCRAFT IS FUELLED 500 kg. GREATER THAN INDICATED BY CHART.
2. FUEL CONSUMPT. IN CIRCLING FLIGHT - 280 kg.
3. UNCONSUMED FUEL - 105 kg.
4. MAXIMUM TOTAL WEIGHT OF FUEL AND LOAD - 20560 kg.

Fig. 12. Maximum Flight Range at Altitude of 8000 m. and Flying Speed of 540 km./hr. Versus Cargo and Fuel Weight before Take-Off.

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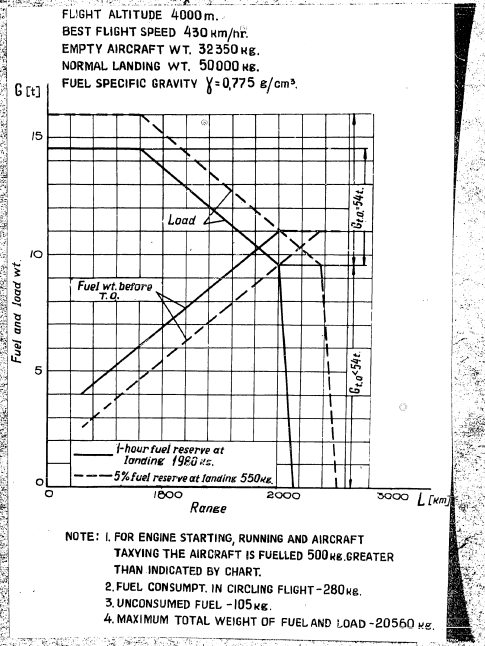

NOTE: 1. FOR ENGINE STARTING, RUNNING AND AIRCRAFT TAXYING THE AIRCRAFT IS FUELLED 500 kg. GREATER THAN INDICATED BY CHART.
2. FUEL CONSUMPT. IN CIRCLING FLIGHT - 280 kg.
3. UNCONSUMED FUEL - 105 kg.
4. MAXIMUM TOTAL WEIGHT OF FUEL AND LOAD - 20560 kg.

Fig. 11. Maximum Flight Range at Altitude of 4000 m. and Flying Speed of 430 km./hr. Versus Cargo and Fuel Weight before Take-Off.

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Tables 4, 5 and 6 give the values of maximum flight range (km.) for the weight of the load carried, altitude and flying speed.

H=10000 m.; V_{true}=575 km./hr. Table 4.

$G_{t.o.}$ (kg.)	G load (kg.)	Flight range (km.)	
		With 1-hour fuel reserve	With 5% fuel reserve
54000	16000	-	1040
54000	14500	1220	1600
54000	9600	3000	3370
52400	8000	3080	3450
49400	5000	3230	3610
46400	3000	3330	3710

H=8000 m.; V_{true}=540 km./hr Table 5.

$G_{t.o.}$ (kg.)	G_{load} (kg.)	Flight range, (km.)	
		With 1-hour fuel reserve	With 5% fuel reserve
54000	16000	-	980
54000	14500	1120	1480
54000	9600	2770	3120
52400	8000	2820	3180
49400	5000	2920	3280
46400	3000	2980	3350

[illegible] V_{true}=490 km./hr. Table 6.

$G_{t.o.}$ (kg.)	G [illegible]	Flight range (km.)	
		With 1-hour fuel reserve	With 5% fuel reserve
54000	[illegible]	-	800
54000	[illegible]	800	1160
54000	960[illegible]	2000	2360
52400	8000	2030	2390
49400	5000	2080	2440
46400	3000	2100	2480

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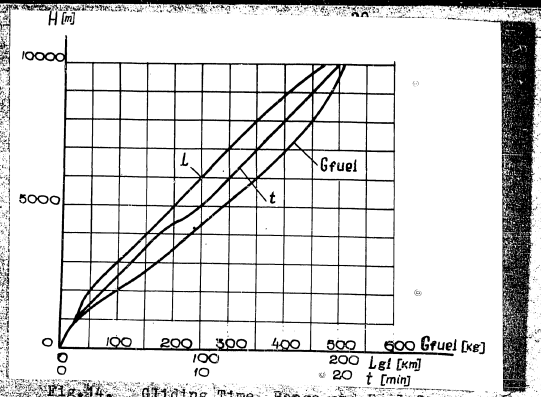

Fig. 14. Gliding Time, Range and Fuel Consumption Versus Altitudes with Engines Running at Idle Rating (20° by VNPT-2 indicator).

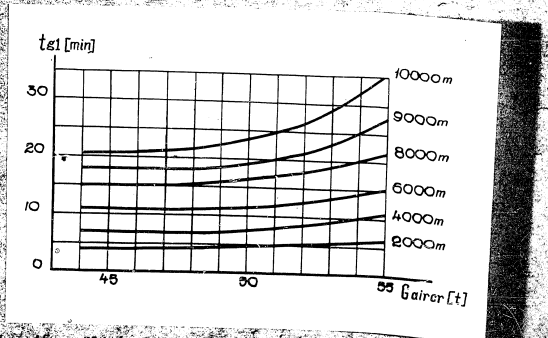

Fig. 15. Climb Time Versus Aircraft Weight with Engines Running at Normal Rating (84° by VNPT-2 indicator).

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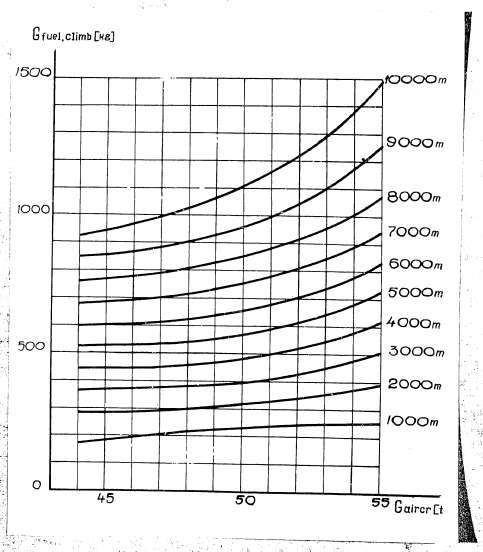

Fig.16. Fuel Consumption in Climb Versus Aircraft Weight with Engines Running at Normal Rating.

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4. TAKE-OFF AND LANDING PERFORMANCE

Take-Off Performance (δ_F =25°)

Table 7.

$G_{t.o.}$ (kg.)	$V_{unstick}$ (km./hr.)	T.O. run on soft ground (m.)	T.O. run on concrete (m.)
51000	214	950	710
54000	220	1080	835

Take-off distance (without the take-off run) up to the altitude of 25 m. at a take-off weight of 51 to 54 t. is 900-1200 m. depending on the take-off weight and pilot's technique.

Fig.17 shows the following relations:

$L_{t.o.\ run} = f(G)$ and $V_{unstick} = f(G)$

Landing Performance (δ_F =35°)

Table 8

$G_{land.}$ (kg.)	$V_{land.}$ (km./hr.)	$L_{land.run.}$ (m.)
48000	208	810 to 960
53000	225	970 to 1100

Landing distance (without landing run) from the altitude of 25 m to the touch-down point is 850 to 1100 m. depending on the landing weight and pilot's technique.

Fig.18 shows the following relations:

$L_{land.run} = f(G)$ and $V_{land.} = f(G)$

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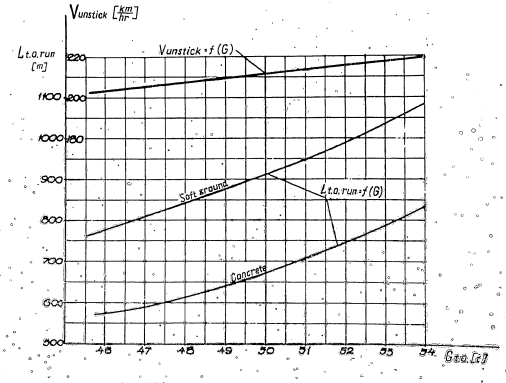

Fig.17. Unstick Speed and Take-Off Run Length Versus Aircraft Take-Off Weight

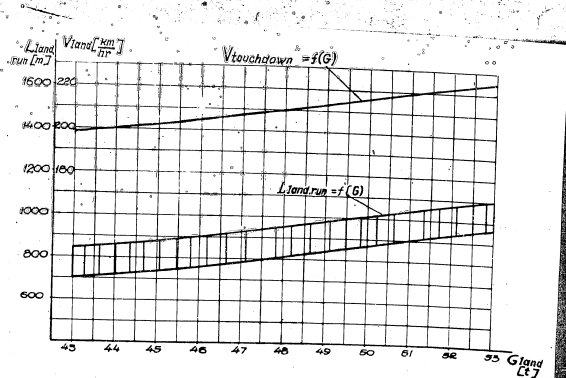

Fig.18. Touch-Down Speed and Landing Run Length Versus Aircraft Landing Weight.

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This chart illustrates that the minimum landing run corresponds to effective application of the wheel brakes during landing run with aerodynamic braking by the propellers applied as soon as possible after touchdown.

The maximum landing run corresponds to the "normal" application of the wheel brakes, i.e. the wheel brakes are applied only at the end of the landing run with aerodynamic braking by the propellers.

5. Aircraft Stability and Controllability

The aircraft has good stability and controllability characteristics within the entire speed and c.g. position range.

The aircraft is easily trimmed at all flight altitudes and in all flight conditions.

Flight with three engines running (the propeller of an outboard inoperative engine being feathered) offers no difficulty to the pilot.

With two running engines located on the same side of the wing, flight can be continued as well as a missed-approach action can be taken or a landing made.

The aircraft remains stable and controlable when properly piloted and no danger arises in all cases as:

- one engine failure during take-off run, when the aircraft comes clear of the ground or climbing;

- failure of two engines located on the same side of the wing in level flight.

and

6. Structural Strength in Operating Conditions

The aircraft structural strength ensures its safe operation with a take-off weight up to 34000 kg.x)

x) The given weight does not include 500 kg of fuel provided in excess of the specified limit for engines running and aircraft taxiing.

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The design landing weight of the aircraft is equal to 50000 kg. In some cases a landing of the aircraft with a weight of up to 53000 kg. is allowed.

When calculating the structural strength, the aircraft operating C.G. position range is assumed to be 18 to 32% of M.A.C. In some cases the forward C.G. limit of 16% M.A.C. is permissible with a force on the control wheel increased up to 45-50 kg.

The minimum speed limited by the maximum dynamic pressure $q_{max.max.}$ = 1800 kg./m^2 and maximum Mach-number equal to 0.7 ($V_{max.max.}$ = 610 km./hr.) is taken as a rated maximum speed $V_{max.max.}$ (Fig.20.).

Maximum indicated airspeed in level flight at a continuous engine rating is assumed to be equal to $V_{max.}$ = 520 km./hr.($q_{max.}$ =1300kg./m^2).

Maximum permissible indicated airspeed with the flaps extended through δ_F =35° is assumed to be equal to 300 km./hr, and with the flaps extended through δ_F =25° = 340 km./hr.

Maximum permissible indicated airspeed with the landing gear down is assumed to be 350 km./hr.

The aircraft is designed as a non-maneuverable airplane.

Given below are operational overloads in the aircraft centre of gravity in flight at speeds up to $V_{max.max.}$ versus flying weight; the operational overload values indicated in the Table are used in strength calculation.

Flying weight, kg.	35000	40000	45000	50000	54000
Max. operational overload	2.8	2.6	2.4	2.35	2.3
Min. operational overload	-1.35	-1.3	-1.26	-1.22	-1.2

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Maximum overload in the aircraft centre of gravity at landing n^{ϑ} =-3.25 (the safety factor in this case is assumed to be equal to 1.65 for the landing gear and 1.8 for the rest aircraft structure).

Strength of the crew and gunner's pressurized cabins ensure an operating pressure of 0.4 atm.

The cargo floor and tie-down fittings are designed to carry freights weighing up to 16000 kg.

No take off or landing is allowed at a cross wind directed at an angle of 90° to the runway and having a speed more than 10 m./sec.

Permissible take-off and landing weights versus the aircraft c.g. position are given in Fig.19.

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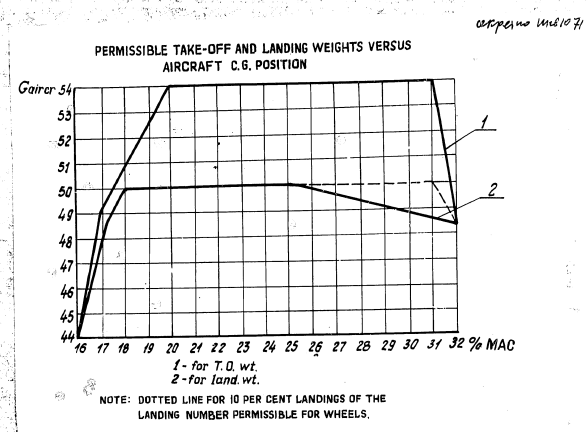

Fig.19. Aircraft Take-Off and Landing Weights Versus Permissible C.G. Position

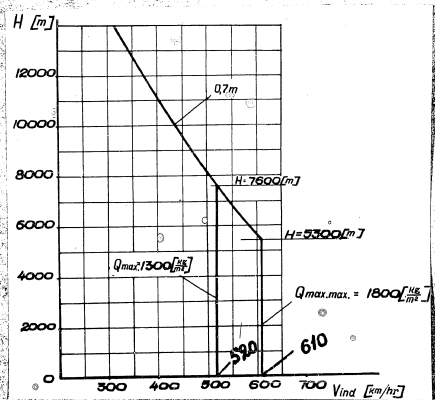

Fig.20. Flight Speed Limited by Permissible Dynamic Pressure and M=0.7

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S E C T I O N IV

AIRCRAFT WEIGHT AND BALANCE DATA

1. Weight Data

1. Take-off weight ..... 54000 kg.
2. Normal landing weight ..... 50000 kg.
3. Maximum fuel weight (γ =0.795 gr/cm^3).. 10800 kg.

NOTES: 1. The aircraft is filled with 500 kg. fuel in excess of the take-off weight of 54000 kg.; this quantity of fuel is used for engine starting, running and aircraft taxying.

2. In some cases landing of the aircraft with a weight of up to 53000 kg. is allowed.

The aircraft take-off weight includes:

1. Empty aircraft weight - 32350 kg. + 0.5% (taken from the aircraft log book) includes:

a) Weight of aircraft structure:

1. Fuselage
2. Wing
3. Tail unit
4. Main landing gear
5. Nose landing gear
6. Aircraft controls
7. Hydraulic system
8. Crew seats

b) Weight of powerplant:

9. Engines AM-20
10. Engine control system

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11. Fuel system
12. Fire extinguishing system and neutral gas system.

c) Weight of equipment:

13. Navigational equipment
14. Radio equipment
15. Electrical equipment
16. Oxygen equipment
17. Fixed photographic equipment

d) Weight of cabin air system:

18. Air conditioning system
19. Heat insulation and sound proofing
20. Door sealing system
21. Wing de-icer system
22. Heating system.

e) Weight of transport equipment:

23. Side seats in cargo equipment
24. Attendants' seats in pressurized cabin
25. Loading ramps (without covering panels) in stowed position.
26. Side static lines

f) Weight of gunnery and bombing equipment

g) Ambulance equipment (fixed)

h) Comfort facilities:

27. Interior finishing
28. Ceiling
29. Curtains on cargo compartment windows
30. Begin crew's cabin
31. Windows engine
32. Air steps

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i) Domestic equipment (fire extinguishers, first aid kits)

II. Load	12077 kg.
1. Crew of six with parachutes	540 kg.
2. Fuel (when filled up to full capacity: γ =0.795)	10800 kg.
3. Oil	328 kg.
4. Ammunition	193 kg.
5. Oxygen	32 kg.
6. Food	30 kg.
7. Additional load	154 kg.
III. Load Carried	16000 kg.

NOTE: The load of 16000 kg. within the landing c.g. position range of 18 to 25.3% M.A.C. is allowed to be carried at the aircraft landing weight of 50000 kg. with 5% fuel reserve at landing.

Weights of Removable Equipment

Nos.	Description	Weight, kg.
1	2	3
	A. Equipment for carrying military freight of up to 5500 kg.	134.0
I.	Loading and cargo tie-down equipment	130.0
	1. Small nets (2)	9.0
	2. Distributing supports (9)	24.2
	3. Lashing cables	43.0
	4. Front jacks (4)	3.5
	5. Rear jacks (4)	3.9
	6. [illegible]-52 winches with brackets (2)	29.4

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2	3
I. Oxygen equipment	
1. Oxygen masks for cargo attendants (9)	4.2
B. Equipment for carrying military freight weighing more than 5500 kg.	189.0
I. Loading and cargo tie-down equipment	184.6
1. Large chocks (2)	40.0
2. Distributing supports (2)	7.8
3. Lashing cables	43.0
4. Front jacks	3.5
5. Rear jacks	3.9
6. PL-52 winches (2)	59.4
7. Small nets (2)	9.0
8. Large nets (2)	18.0
II. Oxygen Equipment	
1. Oxygen masks for cargo attendants (9)	4.2
B. Troop-carrying equipment	
I. Seats installation	152.4
1. Six-seat benches (5)	97.5
2. Four-seat benches (2)	27.4
3. Two-seat benches (1)	8.2
4. Paratroops separator	19.2
II. Oxygen equipment	575.6
1. Oxygen masks, KM-19	42.6
2. Additional oxygen bottles (6)	309.0
3. Oxygen	224.0
III. Ambulance equipment	79.5
1. Drinking water tank (with water)	52.0
2. Water in toilet tank	27.5

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2	3
F. Ambulance version	726.0
I. Ambulance equipment	79.5
1. Water in drinking water tank	52.0
2. Water in toilet tank	27.5
II. Oxygen equipment	394.0
1. Oxygen masks, KM-19	28.2
2. Additional oxygen bottles (4)	206.0
3. Oxygen	160.0

II. Aircraft Balance Data

1. Empty aircraft balance data

Empty aircraft c.g. position is at 22.2±0.5% M.A.C.

2. Theoretical calculation of c.g. position

1) Adopted co-ordinates systems and mean aerodynamic chord position.

Basic co-ordinates system XOY.

- Zero co-ordinates point: the point of intersection of frame No.25) axis with the aircraft horizontal line.
- The "X" axis is directed aft along the horizontal line.
- The "Y" axis is directed upward from the horizontal line.

Wing co-ordinates system X_0OY_0:

- The zero co-ordinates point coincides with M.A.C. beginning.
- The "X_0" axis runs along M.A.C.
- The "Y_0" axis runs down perpendicular to M.A.C.

The M.A.C. position is shown in Fig.21.

2) C.G. position calculation

Detailed C.G. position calculation for take-off, flying and landing as well as the empty aircraft C.G. position calculation when

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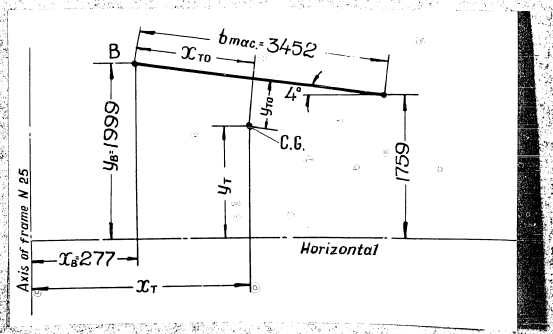

Fig. 21. Mean Aerodynamic Chord Position

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removing or installing new equipment is accomplished in accordance with the following sequence:

a) Fill in the following table:

Nos.	Load items	PX, kg.-m.	X, m.	P, kg.	Y, m	PY, kg.-m.
1	2	3	4	5	6	7

Where:

P - weight of a load item installed or removed;

X,Y - its c.g. position in basic co-ordinates system.

PX,PY - load item static moments about the adopted co-ordinates system axes.

b) Sum up PX, PY moments and weights of the load items.

c) Determine the aircraft C.G. position co-ordinates X_T and Y_T in the basic co-ordinates system.

$$X_T = \frac{\sum PX}{\sum P} \quad ; \quad Y_T = \frac{\sum PY}{\sum P} \quad ;$$

d) Determine the aircraft C.G. position co-ordinates X_{T_0} and Y_{T_0} in the wing co-ordinates system.

$$X_{T_0} = X_T - X_B + Y_{T_0} \cdot tg\alpha ;$$

$$Y_{T_0} = Y_B - Y_T - (X_T - X_B) \cdot tg\alpha ;$$

where X_B, Y_B - M.A.C. forward point position in the basic reference frame.

α - wing setting angle.

e) Determine the aircraft C.G. position in percentage of M.A.C.

$\bar{X}_{T_0}$ and $\bar{Y}_{T_0}$

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$$\bar{X}_{T_0} = \frac{X_{T_0}}{b\ M.A.C.} \cdot 100\%\ ;$$

$$\bar{Y}_{T_0} = \frac{Y_{T_0}}{b\ M.A.C.} \cdot 100\%$$

where b M.A.C. - mean aerodynamic chord.

3. Determining the Aircraft C.G. Position in Operation

Procedure for determining the C.G. position in operation is described in the AN-12 Aircraft Operation Instruction.

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S E C T I O N - V -

AIRCRAFT RIGGING

The aircraft rigging and control surfaces adjustment diagram is given in Fig.22.

When rigging the aircraft observe the following conditions:

1. Mark levelling points on the wing, fuselage and tail unit bottom surfaces; red circles of 10 mm. dia. are painted around the points.

2. Plot the aircraft centre line in plan through the points No.2 and No.4.

Permissible deviation of points 1 and 6 from the C.L. running through points 2 and 4:

point 1 - not more than 3 mm.

point 6 - not more than 6 mm.

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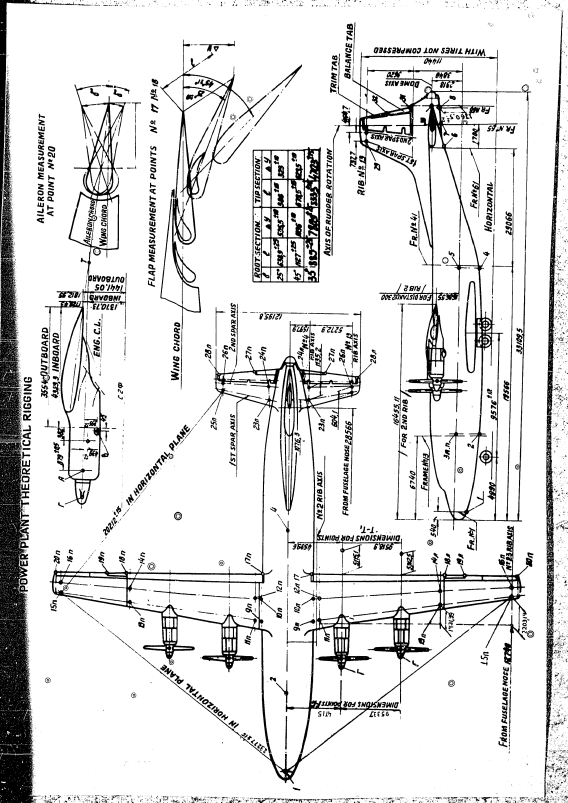

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Table of Rigging Measurements with and without Aircraft Structure and Engines Weight Taken into Account

Table 9.

Purpose of measurement	Measurement description	Dimensions without aircraft structure weight taken into account, mm.	Dimensions with aircraft structure weight taken into account
Levelling F-1 section in flight position.	Elevation of point 1 above 2.	1018.6±2	1019±3
Levelling F-2 section in flight position.	Elevation of point 4 above 2.	242.9±2	247±3
Levelling F-3 section in flight position.	Elevation of point 6 above 4.	3172.4±2	3166±3
Levelling F-5 section in flight position.	Elevation of point 8 above 7.	139.5±2	139±3
Levelling the fuselage.	Elevation of point 6 above 1.	2366.7±2	2367±2
	Elevation of point 5L above point 5R and point 3L above point 3R	0±2	0±2

NOTE: F-1 - fuselage nose section forward of frame 13.
F-2 - fuselage section between frames 13 and 41.
F-3 - fuselage section between frames 41 and 65.
F-5 - gunner's cabin

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Purpose of measurement	Measurement description	Dimensions without aircraft structure weight taken into account, mm.	Dimensions with aircraft structure weight taken into account
1	2	3	4
Wing centre section setting.	Elevation of point 9 above 10.	143.1±4	143±4
Wing setting.	Elevation of point 11 above 12.	139.9±4	140±4
	Elevation of point 13 above 14.	74.3±4	72±4
	Elevation of point 15 above 16.	47.6±4	45±4
Wing dihedral angle.	Elevation of point 13 above 11.	196±4	142±10 allowable difference between R and L measurement not more than 8 mm.
	Elevation of point 13 above 15.	180±4	224±6 allowable difference between R and L measurement not more than 12 mm.
	Elevation of point 9L above 9R.	0±0.5	-
	Elevation of point 13L above 13 R	0±11.5	0±2
Stabilizer setting	Elevation of point 24 above 23.	50.5±3	50±3
	Elevation of point 26 above 25.	26.9±3	27±3
Stabilizer dihedral angle	Elevation of point 25L above 25R	0±3	0±3
	Elevation of point 26L above 24L and point 26L above 24R	50.04±2	49±2
Levelling the aircraft in	Elevation of point 6 above 1	2366.7±2	2367±2

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1	2	3	4
flight position.	Elevation of point 13L above 13R	0±11.5	0±2
	Elevation of point 9L above 9R	0±0.5	0±1

Deflection of Ailerons, Rudder, Elevator and Trim Tabs

Table 10.

Control surfaces	Deflection, deg.		Deflection, mm.	
	Up	Down	Up	Down
1	2	3	4	5
Aileron: measured at point 20.	$25^{\circ}\pm1^{\circ}$	$15^{\circ}{}^{+2^{\circ}}_{-1^{\circ}}$	164.5±6.5	$99.5^{+13}_{-6.5}$
Aileron trim tab; measured at point 19.	$8^{\circ}-1^{\circ}$	$8^{\circ}-1^{\circ}$	27-3.5	27-3.5
Aileron balance tab, measured at point 19.	$9^{\circ}45'\pm1^{\circ}$	$16^{\circ}15'\pm1^{\circ}$	32.3±3.5	55.5±3.5
	To left	To right	To left	To right
Rudder; measured at point 31.	$24^{\circ}\pm1^{\circ}$	$24^{\circ}\pm1^{\circ}$	611.4±25	611.4±25
Rudder trim tab; measured at point 32.	$15^{\circ}\pm1^{\circ}$	$15^{\circ}\pm1^{\circ}$	41.4±4	41.4±4
Rudder balance tab; measured at point 31.	$13^{\circ}30'\pm1^{\circ}$	$13^{\circ}30'\pm1^{\circ}$	51.2±4	51.2±4
	Up	Down	Up	Down
Elevator; measured at point 28.	$28^{\circ}\pm1^{\circ}$	$15^{\circ}\pm1^{\circ}$	149±5.5	80±5.5
Elevator trim tab; measured at point 27 (cable control)	$12^{\circ}\pm1^{\circ}$	$12^{\circ}\pm1^{\circ}$	32.9±3.5	32.9±3.5

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1	2	3	4	5
Elevator trim tab; measured at point 27 (Electric control)	$10^{o}+0^{o}_{-1^{o}}$	$10^{o}+0^{o}_{-1^{o}}$	$27^{o}+0^{o}_{-3^{o}}$	$27^{o}+0^{o}_{-3^{o}}$

Power plant rigging measurements with and without wing droop and twist taken into account

Table 11.

Points	A				B				C	
Engine installation	Inboard		Outboard		Inboard		Outboard		Inboard	Outboard
Distance between outboard points and aircraft horizontal line.	1378.29	1378±5	1446.61	1415±0.6	1333.06	1332±5	1403.38	1374±10	982.42	-
Elevation of outboard points above inboard points.	15.1±1	13±2	15.1±1	7±3	12.44	-	12.44	-	13.3±1	-

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S E C T I O N VI

TRANSPORT EQUIPMENT

I. AIRCRAFT CARGO COMPARTMENT EQUIPMENT FOR TRANSPORTING EQUIPMENT AND CARGOES

1. Tie-Down Fittings.

Equipment and cargoes are located in the aircraft cargo compartment on the cargo floor which consists of a reinforced framework and panels.

Installed in the cargo floor framework in places where longitudinal beams cross with lateral ones are tie-down fittings (fig.23) to lash the equipment and cargoes with cables and nets during transportation.

The tie-down fittings are arranged in four rows, 14 fittings in each row; besides, one more tie-down fitting is installed on frame 43 between each pair of the rows.

The total number of tie-down fittings is 59. They are spaced in staggered row.

The tie-down fittings of all the four rows are attached in the region of frames 13 to 27 and 34 to 43 to the upper sections of the cargo floor framework beams and to the stamped tie-down cups.

The tie-down fittings of all the four rows in the region of frames 27 to 33 are of screw-type and attached to special fittings riveted to the floor framework.

The tie-down fittings of the extreme rows on frames 42 and 43 are of screw-type and attached to the fittings of framework longitudinal beams.

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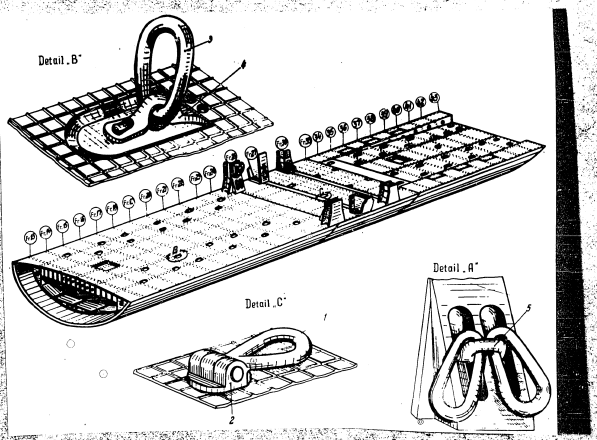

Fig.23. Tie-Down Fittings Location.

1 - Tie-down ring; 2 - tie-down fitting; 3 - tie-down ring; 4 - clamp; 5 - clamp.

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The tie-down fittings consist of a clamp and ring; the screw--type tie-down fittings consist of a ring and screw-type eye-bolt.

In stowage position all the rings of the tie-down fittings are flush-mounted with the cargo floor covering and are spaced in the tie-down cups recesses.

The clamps of the screw-type tie-down fittings project against the cargo floor covering and, if necessary, they may be screwed out and placed in a pocket located in the baggage compartment. The tie--down fittings are designed to withstand a 7,500 kg. load acting in the direction of the lashing cable.

2. Lashing Cables

The lashing cables (Fig.24) consist of a steel cable one end of which is provided with a hook, the other one - with a lock and catch.

Applied to the aircraft are 36 cables 8 mm. dia.: 14 ea 4,000 mm. long and 22 ea 7,500 mm. long.

The lock consists of the hook, lock (13), bushing (14), coupling (2), spring (9), bushing (3), hand wheel (4) and eye bolt (5).

The hook is screwed in the bushing (3) and locked with a pin.

In locked position the lock and is secured with the coupling. To open the lock draw back the coupling (2), turn the lock and withdraw it from the tie-down ring.

Screwed in the bushing (3), having inner right hand thread, is the hand wheel (4) with inner left hand thread into which the eye--bolt (5) is screwed. The hand wheel (4), the eye-bolt (5) together with the bushing (3) serve as a turnbuckle and operate for cable tension or release. The total travel of the turnbuckle is 100 mm.

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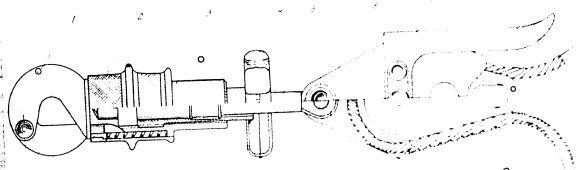

Fig.24. Lashing Cable with Lock.

1 - hook; 2 - coupling; 3 - bushing; 4 - hand wheel; 5 - eye bolt; 6 - housing; 7 - handle; 8 - insert; 9 - spring; 10 - hook; 11 - pin; 12 - cable; 13 - lock; 14 - bushing.

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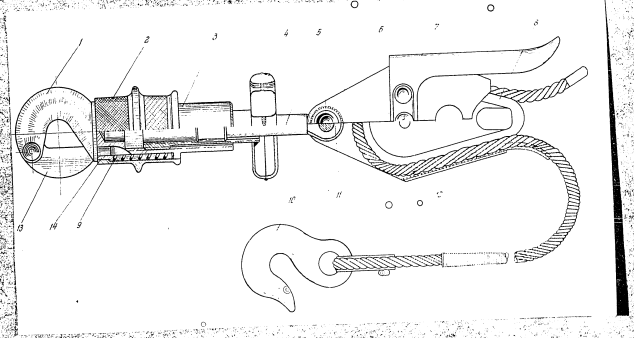

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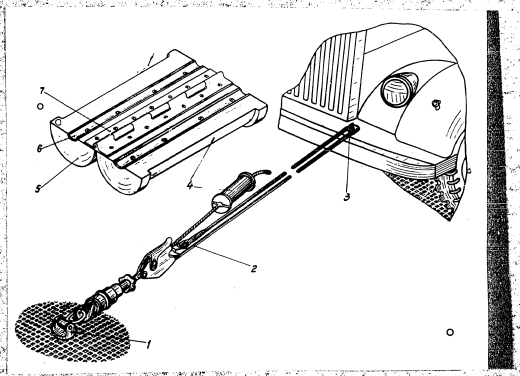

Fig. 25. Tightening the Cable when Lashing.

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A wedge - type catch provides for cable length adjustment and its proper fastening.

The cable passes along the grooves between the insert and housing if one of the cable ends is pulled, the cable is tightened between the insert (8) and housing (6). To loose the cable for moving it through the catch press the handle (7), thus releasing the insert, and keep it so when moving the cable.

The clamp is hinged to the lock eye bolt (5). To tie-down the equipment, hook the cable lock by one of the nearest lashing rings, route the cable around the hook or other element of the equipment to be lashed and hook the free end of the cable by the eye of the catch insert.

Then pull up the cable slack and strain the cable with the turnbuckle.

When pulling up the cable use a special handle (Fig.25).

3. Cargo Holding Nets

To secure small cargoes in the aircraft two types of cargo holding nets are used (Fig.26) which differ from each other in size. The smaller nets are made of a flax rope 6 mm.dia.; they are edged with a rope 12 mm.dia., to which textile straps are attached.

The locks, placed on the straps, consist of the hook (4) with the clamp and lock (3), casing (6), bushing (1) on the axle (7), spring (2) and pin (5) on which the hook (4) rotates.

The hook (4) with the clamp, rotating about the pin (5) is compressed by the spring (2) to the bushing (1) which can also rotate freely about the hollow axle (7). The free end of the strap sewed in the net passes in between the hook clamp and bushings and may be easily

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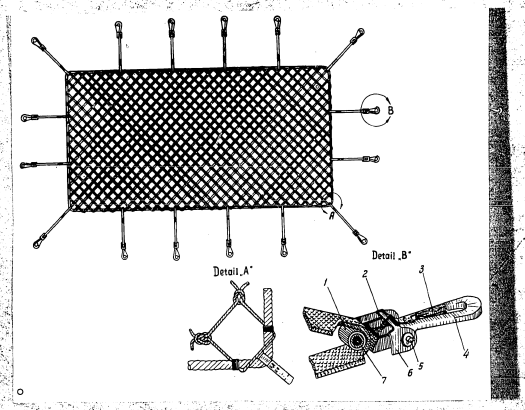

Fig.26. Cargo Holding Net.

1 - Bushing; 2 - spring; 3 - look; 4 - hook; 5 - pin; 6 - casing; 7 - axle.

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oved in one direction. When being moved in the opposite direction he strap is compressed between the bushing and knurled clamp.

When unlashing the cargoes release the clamp and loosen the strap, hen disconnect the lock from the lashing ring.

The larger net differs from the smaller one in size and in that t is made of a flax rope 8 mm.dia.

4. Wheel Chocks and Load Distributors

When transporting wheeled equipment in the aircraft place the heel chocks and load distributors under the wheels to restrict their ovement and to distribute wheel load over the floor framework.

Depending on equipment being loaded use the wheel chocks (Fig.27) or the load distributors(Fig.28).

The wheels of the loaded equipment rest on the frame lateral sections and the bow. The chocks are installed under the wheels of the loaded equipment with the bow forward.

The load distributors are installed under the two-tyre wheels of the loaded equipment and under all the wheels if the weight of the loaded equipment exceeds 7.5 tons.

5. Jacks to Release Wheel Suspension

When transporting trucks install jacks (Fig.29) on the truck chassis between the front suspension springs and the truck frame and between the rear axle and rubber support on the truck frame to release the wheel suspension.

To release the suspension springs the front jack is installed with its base resting on the front suspension spring forward of the front axle and the jack screw is screwed out till it rests on the frame.

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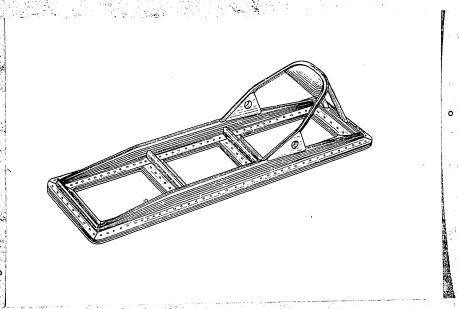

Fig.27. Wheel Chock

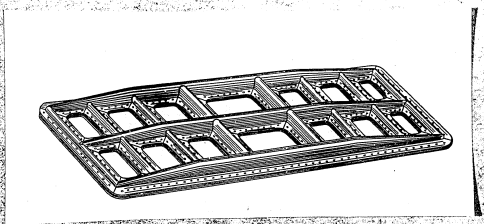

Fig.28. Load Distributor

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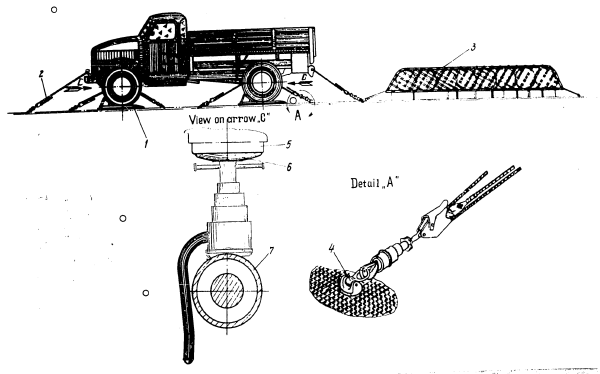

Fig.29. Installing Jacks to Release Wheel Suspension, Cargo Holding Net and Wheel Chocks.

1- chock; 2- lashing cable; 3- cargo holding net; 4- tie-down fitting; 5- rubber support; 6- jack; 7- truck rear axle;

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The rear jacks are installed on the rear axle of the truck and their rups rest on the rubber support on the truck frame.

II. LOADING EQUIPMENT

The equipment and cargoes are loaded or unloaded through the cargo door by means of the loading ramps (Fig.30); the self propelled equipment is loaded by its own power and towed equipment - by means of the electrically remote-controlled winches.

Besides, the towed wheeled equipment may be loaded or unloaded by means of a tractor. To protect the ramps and cargo compartment floor against damage when loading tracked equipment rope + mats coverings. To decrease the ramp angle install the supports under the ramps lower ends.

After the cargoes are loaded into the aircraft place the loading ramps in the stowage position in the region of frames 34 and 42.

1. RM-52 Electrical Winch System

To load the towed wheeled equipment weighing up to 8.5 tons into the aircraft, the RM-52 electrical winch system with loading cables is used (Fig.21).

The RM-52 electrical winch system includes:

- two RM-52 electrical winches with MM-500 drive electric motors;
- two AMV-I amplidynes supplying the winch drive electric motors;
- CVT-47 control box, incorporating communication equipment;
- UVT-47 control panel intended for remote controlling the winches;
- instruments and electrical system cables.

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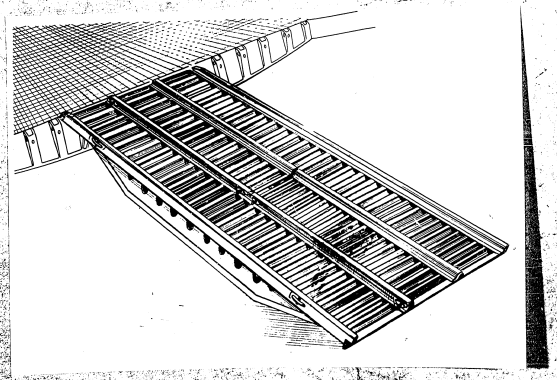

Fig.30 - Loading Ramp Placed in Operating Position

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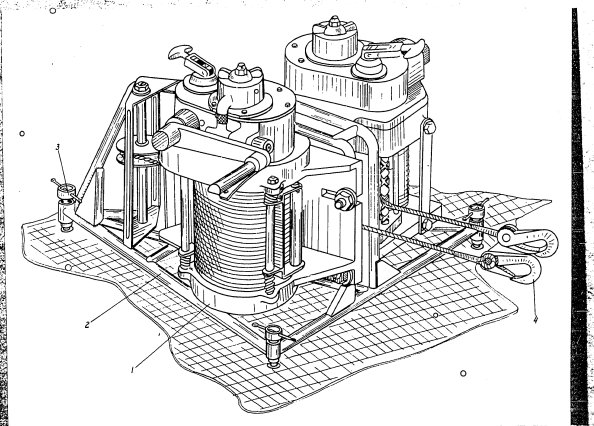

Fig. 31. ЕЛ-52 Winch for Loading Equipment

1 - winch; 2 - winch attachment mount; 3 - mount attachment bolts.

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To facilitate operation, the AMV-I amplidynes, control box and instruments are mounted on a special T-CVJ-52 cart.

Winch System Technical Data

1. Winch cable operating load - up to 500 kg.
2. Power consumed by the system at simultaneous operation of two winches with a cable load of 500 kg. per each cable, at a temperature of 20°C and voltage of 27 V - not more than 4 kwt.
3. Operating supply voltage - 27 ± 2 V.
4. Max. speed of loading cargoes with a cable load of 500 kg. - not less than 4 m./min.
5. Min. speed of loading cargo - not more than 0.5 m./min.
6. Reduction gear ratio:
   for electric drive - 262
   for manual drive - 14.6
7. Drive crank force with a cable load of 500 kg. - not more than 15 kg.
8. Cable movement velocity when manually driven at n=35 r.p.m. - 1 m./min.
9. Operating duty:
   with a cable load of 500 kg.
   operating duty is intermittent:
   15 cycles for 53 minutes; each cycle consisting of 1.5 minutes of operation and 2 minutes interval, after 15 cycles - complete cooling of the system.

With a cable load of not more than 375 kg. the system may be used for loading for 1.5 hours, including intervals between loadings the cargo, then it should be cooled completely.

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10. Length of cable wound around the winch drum - 30 m.

11. Cable diameter - 5 mm.

12. Weight of winch set together with control system - not more than 190 kg.

BL-52 WINCH INSTALLATION

To load equipment into the aircraft the BL-52 winches are installed in the working position on two mounts which are attached to the sockets located on frames 14 and 15 on both sides of the aircraft line of symmetry.

One of the mounts is intended for installation of both the winches on it.

2. LOADING CABLES AND SUPPORTING ROLLER

A system of cables and pulleys is used to load and unload equipment by means of BL-52 electrical winches.

The system provides for loading the equipment weighing up to 8.5 tons; the cable and pulley system is assembled depending on the weight of the loading equipment in accordance with Fig.32.

When loading several pieces of equipment the tension pulleys are used to prevent the cables from friction against the angles of the cargoes that have already been loaded (Fig.33).

When loading or unloading equipment, install the supporting roller at the cargo compartment threshold in special sockets (Fig.34); the roller supports the loading cable in place of its bend.

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3. LOADING EQUIPMENT BY TRACTORS

If the winch is not available on the aircraft, load the equipment by tractor or by truck. (Fig. 35)

For this purpose, applied to the loading equipment set is a loading cable 6 mm.dia., one end of which is fitted with a caprone strap, the other one - with a hook.

Two pulley blocks (each of them isacasing with a pulley) are placed on the cable.

The pulley blocks casings have hooks, by means of which the blocks are attached to the tie-down rings. The pulleys of the blocks may self-center under the action of the cable load.

Besides the pulley blocks a pulley tackle is placed on the cable, with the straightening cable preliminarily removed from the pulley tackle.

Attached to the pulley tackle eye by the hooks are both ends of the loading cable the loop of which holds the hook of the cargo to be loades.

When loading equipment the pulley blocks are attached by their hooks to the lashing cables in the region of frames 16 and 24.

The loading cable is hooked to the lashing ring in the region of frame 14, passes through the pulley tackle and loading pulley blocks, then it is routed through the aircraft entrance door overboard the aircraft where it is attached by the caprone strap to the tractor towing hook.

A textolite plate is installed at the entrance door threshold to prevent the latter from damage by the cable.

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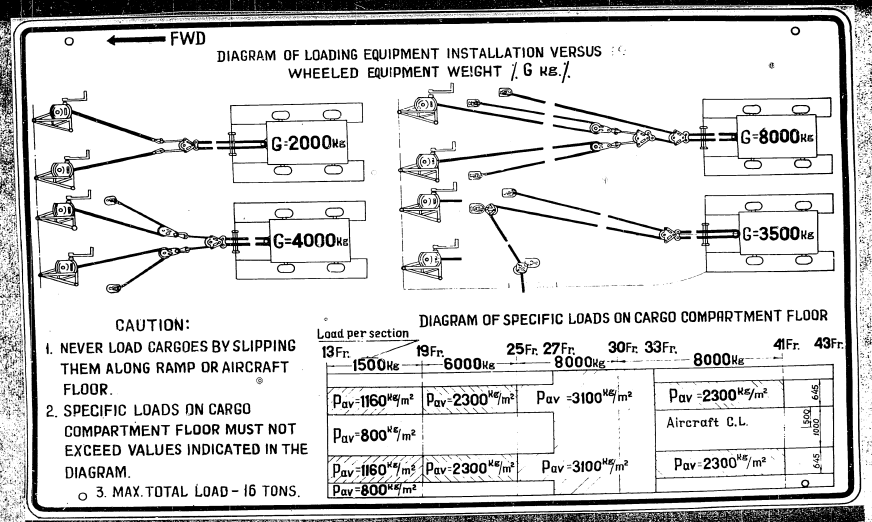

Fig. 32. Loading Equipment Installation Diagram.

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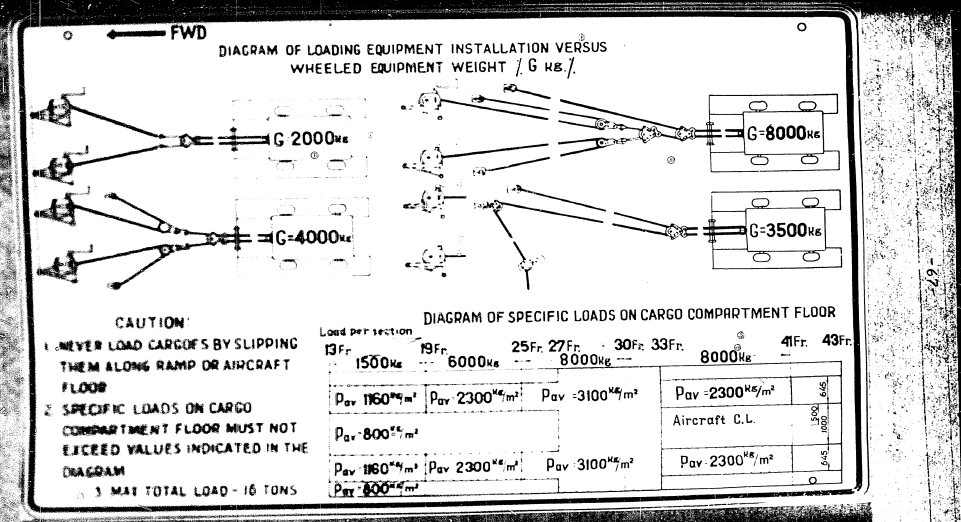

Fig. 32. Loading Equipment Installation Diagram.

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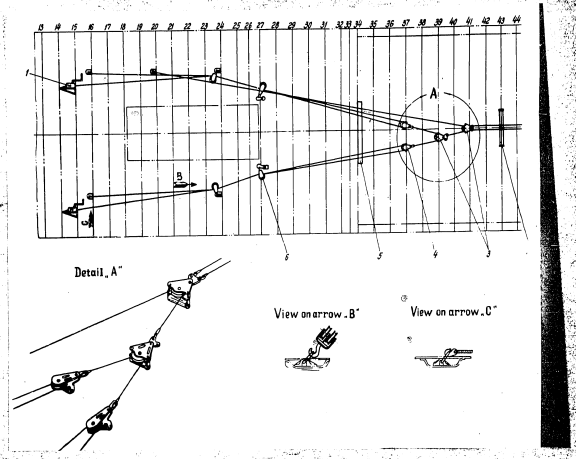

Fig. 33. Diagram of Loading Equipment Installation to Load Two Cargoes

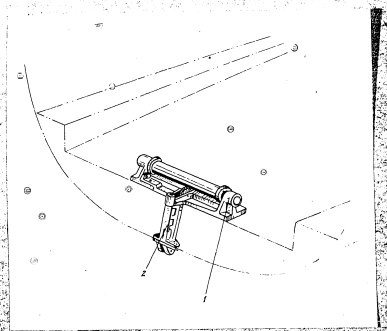

Fig. 34. Supporting Roller

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4. LOADING EQUIPMENT STOWAGE

The removable loading equipment is stowed in front baggage compartment under the floor. The equipment is secured by the cargo holding

If necessary, when loading or unloading the equipment on airfields where the aircraft is not based keep the LM-52 winches and mounts in the working position, load the T-CVL-52 cart and tie down it in the aircraft cargo compartment.

Otherwise stow the LM-52 winch and its mount, as well as the T-CVL-52 cart on the airfield in a closed room.

5. CONVEYER

The conveyer (transporter) is designed for mechanization of the loading or unloading operation when transporting different cargoes in the aircraft, as well as for paralanding of supplies having total weight up to 9,000 kg.

The conveyer consists of three units:

- lines on which transported cargo are placed and moved along the cargo compartment;
- electrical actuator driving the transporter;
- mechanism for retracting tie-down straps.

Operating Data

1. Conveyer length	13,345 mm.
2. Width, as measured by extreme lines	1,822 mm.
3. Conveyer load carrying capacity	9,000 kg.
4. Conveyer chain speed:	

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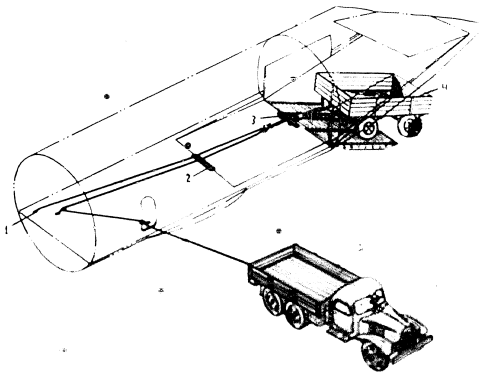

Fig. 35. Load the equipment by Tractor or by Truck.

1. Lashing point; 2. cover plate on the floor; 3. supporting rollers; 4. Wheeled equipment to be loaded; 5. truck.

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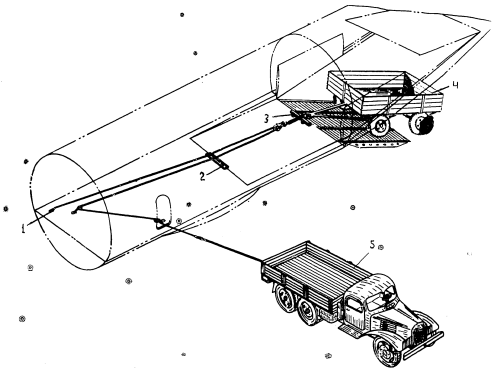

Fig. 35. Load the Equipment by Tractor or by Truck.

1. Lashing point; 2. cover plate on the flow; 3. supporting roller; 4. wheeled equipment to be loaded; 5. truck.

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- maximum ..... 0.84 m/sec.
- minimum ..... 0.19 m/sec.

5. Time of conveyer complete actuation from the moment of switching on to the moment of stopping by the rear limit switch ..... 15 sec.

The tie-down strap retraction mechanism consists of four drums to reel up the tie-down straps after dropping cargoes by the conveyer (Fig.36).

Each drum is placed in a detachable casing. The casings are installed on the cargo compartment ceiling between frames 40 and 41.

Mounted on the left drum casing (viewing in the direction of flight) is the MIE-8 electric actuator, which is connected directly to the drum axle and transmits rotation to the other drums via transmitting shafts.

The axles are frictionally connected to the drums, which provides for smooth reeling up the loose straps onto the drums when the cargo is unlashed, and also their smooth reeling off when lashing the cargoes. The force at the beginning of strap reeling off equals to 10+2 kg.; with decrease in the diameter of the reeled-up strap, when reeling off, the force increases up to 30+5 kg.

Friction is adjusted by means of the castellated nut located on the shaft on the right side, as viewing in the direction of flight.

To avoid twisting of the strap when reeling it up onto the drum, two floating pulleys pressing the strap are provided.

In the cargo compartment four 8 mm. dia. static cables are mounted (Fig.37).

The static cables tension is adjusted by the turnbuckles.

After dropping the cargoes from the aircraft static lines remain on the static cables; the static lines are spread along the cargo door and pressed by the air flow to the rear and side doors.

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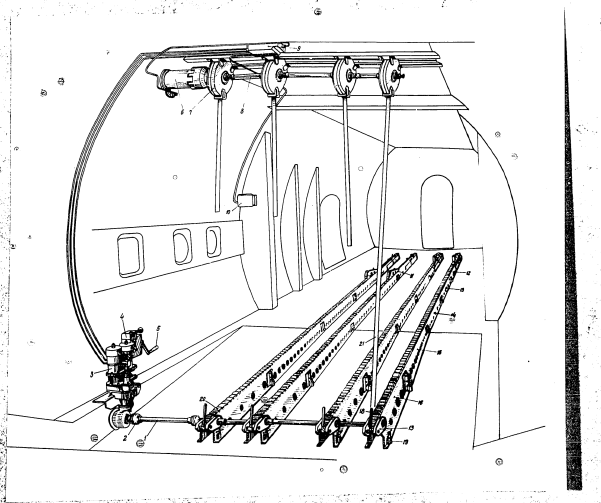

Fig.56. Installation of MI5T Conveyer in Cargo Compartment

1 - Transmission shaft; 2 - coupling; 3 - drive electric motor model MIK-I3 ; 4 - manual drive; 5 - crank; 6 - MMM-8 drive actuator; 7 - tie-down strap winding drum; 8 - transmission shaft; 9 - contactor box; 10 - operator's control panel; 11 - stop; 12 - 1-st section; 13 - 2-nd section; 14 - 3-d section; 15 - 4-th section; 16 - 5-th section; 17 - bracket; 18 - guide; 19 - attachment bracket; 20 - conveyer chain; 21 - tie-down strap.

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To retract the static lines to the cargo compartment an electric actuator is provided (Fig.37).

The static lines are retracted to the cargo compartment by special sliders (3) and (4), driven by the electrical winch (16).

When the navigator or operator switch on the winch, the cable(6) with the ring moves inside the fuselage and draws the front slider(4) which is connected to the cable ring by spring hooks; the front slider (4) in its turn draws the rear slider (3).

To restrict the sliders movement backwards, the static cables are fitted with limiters, whereas to restrict their movement forward a braking mechanism (8) is installed on frames 31 and 32.

Shown in Fig.38 is the electrical winch to retract the static lines. The drum (5) having a screw groove is installed on the axle(4) rotating in the ball bearings which are pressed in the casing (2) and the cover (6).

The rod (13) which has a rectangular cross-section is screwed in the axle (4).

Inserted in the rod slot are two cams by means of which the limit switches (9) of the electric winch control are actuated.

The MB-300 electric actuator is attached to the winch by means of a flange.

The winch rotates to one side till the cam engages the corresponding limit switch.

The braking mechanism (Fig.37) serves to decrease idle running of the winch drum after the electric actuator is switched off.

The braking [illegible] consists of a casing (8) on which sheet [illegible] and a slide with a guide strip are mounted.

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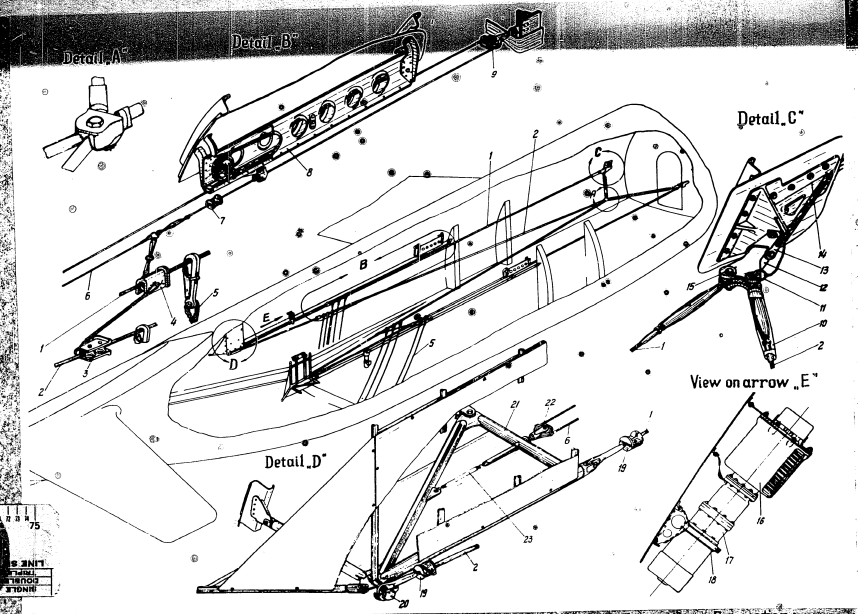

1,2 - static cables; 3 - slider; [illegible] 6 - winch cable; 7 - stop; 8 - braking mechanism housing; 9 - pulley; 10 - cover; 11 - ring [illegible] int; 13 - intermediate bracket; 14 - cable attachment bracket; 15 - pin; 16 - winch; 17 - MB-300 electric actuator; 18 - clamp; 19 - stop; 20 - bolt; 21 - frame; 22 - pulley; 23- spring.

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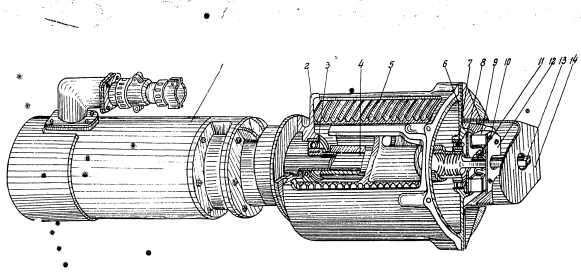

Fig.38. Electric Actuator with Winch

1 - MB-300 electric actuator; 2 - winch housing; 3 - ball bearing; 4 - axle; 5 - drum; 6 - cover; 7 - ball bearing; 8 - disk; 9 - limit switch; 10 - screw; 11 - stop; 12 - plate; 13 - rod; 14 - shield.

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6. AMBULANCE EQUIPMENT

In the basic loading conditions the cargo compartment can accommodate 60 stretcher cases and three medical attendants. Besides 9 sitting patients can be accommodated on the side seats in the cargo compartment and 9 more sitting patients - on the seats in the forward pressurized cabin.

Other loading conditions of the aircraft in the ambulance version are possible.

The stretchers are arranged in three rows. Each row contains four tiers (Fig.39).

One row of the stretchers is installed along the aircraft starboard on one row of supports and one row of straps; two other rows of stretchers are installed on one row of supports and two rows of straps. Places for three medical attendants are equipped with folding tables and side seats.

A welded aluminium reservoir of 50 litres capacity is installed on the aircraft portside on frame 25 lining to provide the patients with water. The electrical coffee-boiler installed on frame 9 may also be used to provide patients with a fresh boiled water.

Located on the rear cargo door segment is a toilet, which is equipped with a closet, wash-basin, three bed pans and three urinals.

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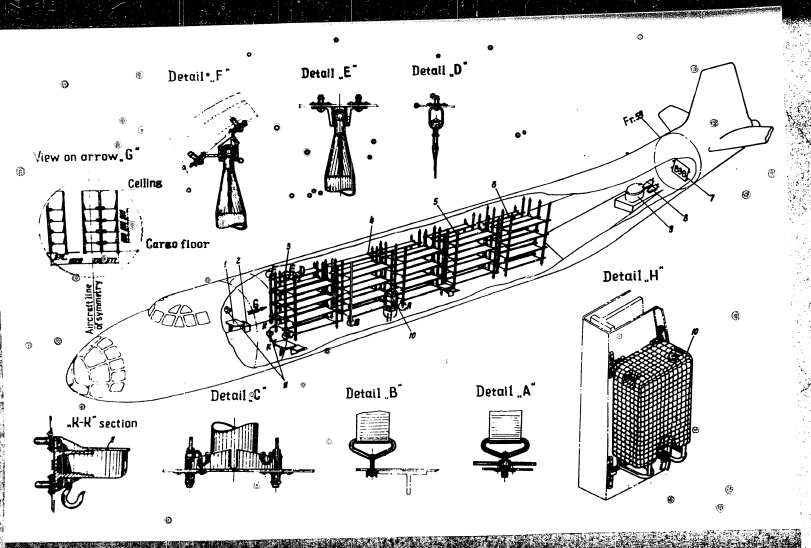

Fig.39. Ambulance Equipment Location

1 - Medical attendant's table; 2 - seat; 3 - central supports attachment fitting; 4 - stretchers attachment fitting; 5 - stretcher straps; 6 - stretchers; 7 - urinals; 8 - bed-pans; 9 - closet; 10 - drinking water tank; 11 - nursing cup attachment bracket.

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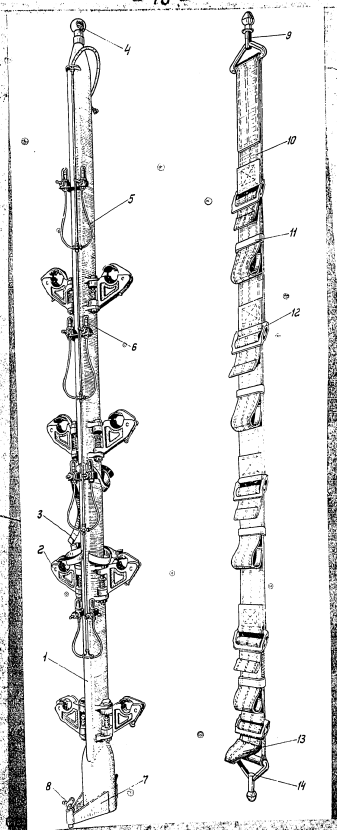

Fig.40. ment strap ;-

1 - Support; 2 - stretcher attachment lock; 3 - stretcher strap; 4 - hail supports; 5 - oxygen pipes; stowage position attachment belt; 6 - oxygen flow indicators; 7 - base; 8 - wing hooks; 9 - upper bracket; 10 - straps; 11 - eye; 12 - stretcher attachment buckle; 13 - strap end; 14 - lower bracket.

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SECTION VII

ARMAMENT

1. GUN ARMAMENT

To protect the aircraft from enemy attacks in the rear hemisphere, the aircraft is provided with a gun installation which incorporates a ДБ-65У electric remote-control tail gun turret (Fig.41), КПС-53А sighting station with a ВБ-257-1е computer, remote control units and "Gamma-54T" range finder radar.

The ДБ-65У tail gun turret with 23-mm. guns is a gun installation with an electric follow-up drive.

The КПС-53А sighting station is designed for the tail gun turret control and together with the ВБ-257-1 computer ensures aimed firing.

The tail gun turret movement electric remote-control is based on the synchronous follow-up drive employing an electronic-magnetic amplifier.

Installed on the turret is an antenna and waveguide of the "Gamma-54T" range finder radar designed to determine the distance to a target and to send to the sight through the computer electric signals which are functions of the distance to the target; the distance is measured considering the time required for electromagnetic energy to pulses/radiate from the range finder radar antenna to the target and backward.

The tail gun turret is fitted with an АЗ-47 automatic gun recharger which ensures automatic electro-pneumatic recharging of the guns.

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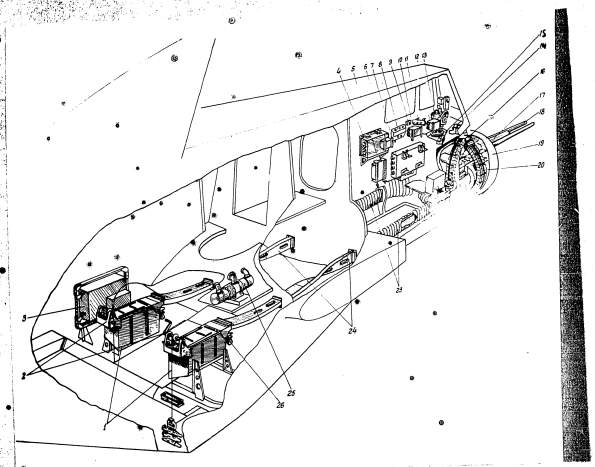

Fig.41. Location of Gun Armament Units.

1-ammunition boxes; 2- winches; 3- АВС-257-1 flight fire automatic unit; 4- У-2К-1 amplifier; 5- У-2М-16И amplifier; 6 - А3-1АМ fire interrupter unit ; 7- КУК-54В tail gun installation control box; 8 - gunner's left control panel ; 9 - dimmer switch ; 10 - КЭП-4 ammunition booster box ; 11- ДСП-257 air speed and density unit ; 12 - КЭП-4 ammunition booster box ; 13- КПС-53А sighting station ; 14 - ОП-54Т main control panel; 15- ВП-54Т auxiliary control panel ; 16 - rigid ammunition chute ; 17- "Гамма"-54Т antenna; 18 - АМ-23 guns ; 19 - barrel fairing ; 20 - flexible ammunition chute ; 21 - ammunition booster ; 22 - АП-27 automatic gun rechargers; 23 - hermetic housing ; 24 - rigid ammunition chute ; 25 - БА-3Д rotary amplifier ; 26 - ammunition booster;

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ДБ-65-У TAIL GUN TURRET MAIN DATA

Armament	Two 23-mm. guns AM-23.
Ammunition	500 rounds (250 per gun)
Firing angles:	
- azimuth	70° to the right 70° to the left
- elevation	60° up 40° down
Drive type	Electric
Fire and gun movement control	Electric remote control
Gun recharging	Automatic electro-pneumatic
Case-and-link ejection	Overboard

REMOTE CONTROL SYSTEM

D.C. power source voltage	27 v.
A.C. power source voltage	115 v.
Frequency	400 c.p.s.
Power consumed by the system from D.C. power source	5000 W
Power consumed by the system from A.C. power source	500 VA

1. LOCATION OF RB-23V SYSTEM UNITS

Most of the tail gun turret remote control units - KVK-54B tail gun installation control box, V2M-I and V2M-IBM amplifiers, two KZP-4 ammunition booster boxes, AP-27 automatic gun rechargers, OP-54T and BP-54T control panels are located in the gunner's pressurized cabin.

The EA-3P rotary amplifier is mounted outside the pressurized

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cabin between frames Nos. 60 and 61.

The КПС-53А sighting station, ДСП-257 air speed and density unit and АТЗ-157 charge temperature unit are installed in the gunner's pressurized cabin.

The Б6-257-1 computer is mounted outside the pressurized cabin on the starboard in the area of frame No.61.

The ammunition is contained in two ammunition boxes placed between frames Nos. 50-62.

The ammunition is fed from the box to the turret through the rigid chutes by two ammunition booster assemblies for each gun.

The "Gamma" range finder radar units are installed outside the pressurized cabin in the area of frame No.59.

2. TURRET INSTALLATION

The turret is installed on the fuselage rear frame aft of the gunner's pressurized cabin.

The turret is bolted to frame No68 through the upper and lower brackets.

The turret is covered with a special fairing attached to the sections of frame No.68.

3. SIGHTING STATION

The КПС-53А sighting station designed for the turret control is installed on a special pedestal in the gunner's pressurized cabin.

The pedestal permits adjusting the sight in azimuth and elevation.

4. Б6-257-1 COMPUTER

The Б6-257-1 computer incorporates the АВК-257-1 flight fire automatic unit, ДСП-257 air speed and density unit and АТЗ-157 charge temperature unit.

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The ABC-257 flight fire automatic unit is designed to automatically solve the problems of flight firing at an attacking aircraft.

The AGU-257 air speed and density unit is designed to manually introduce the air speed and density data into the flight fire automatic unit.

The AT3-157 charge temperature unit is designed to manually introduce the cartridge charge temperature data into the ABC-257-1 fire automatic unit

The AT3-157 unit is installed in the gunner's pressurized cabin.

5. GUN INSTALLATION CONTROL BOX

The KYK-54B tail gun installation control box is designed for automatic switching of the circuits of the units incorporated in the turret remote control system.

The KYK-54B control box is installed on the fuselage port side.

6. MAIN CONTROL PANEL

The BU-54T main control panel is used for automatically controlling the fire and checking the "Gamma" range finder radar operation.

The control panel is installed on the port side of the pressurized cabin (Fig. 43).

7. AUXILIARY CONTROL PANEL

The BU-54T auxiliary control panel is used for switching power supply to the turret automatic control circuits.

The BU-54T auxiliary switch panel is installed on the port side of the pressurized cabin.

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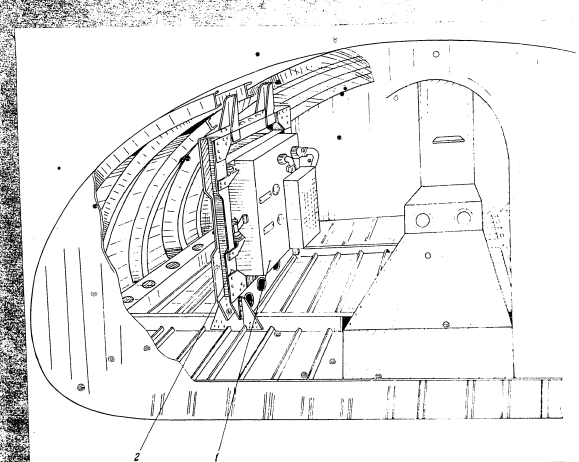

Fig. 42. ABC-257-1 flight fire automatic unit.

[illegible] fire automatic unit. Mounting frame.

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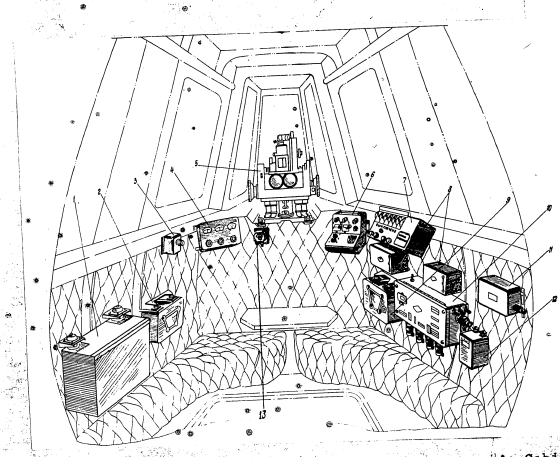

Fig. 43. Location of Gun Armament Units in Gunner's Cabin (F-5)

1 - У-2М-I amplifier; 2 - АП-27 automatic gun recharger; 3 - sight dimmer switch; 4 - ДСП-257 air speed and density unit; 5 - КПС-53А sight; 6 - ОП-54Т main control panel; 7 - ВП-54Т auxiliary control panel; 8 - КЭП-4 ammunition booster boxes; 9 - АП-27 automatic gun recharger; 10 - КУК-54Б tail gun installation control box; 11 - А3-1АМ fire interrupter unit; 12 - У-2М-1БИ amplifier; 13 - ДТЗ-157 charge temperature unit;

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8. AMPLIFIERS

The remote control system incorporates two amplifiers: У-2М-IБМ and У-2М-I . The amplifiers are employed for amplifying the selsyn signal voltage to the value required for the rotary amplifier control and selection of a signal from the fine or coarse selsyn. The У-2М-IБМ amplifier increases the main У-2М-I amplifier amplification factor.

The У-2М-I amplifier is installed on the fuselage starboard in the gunner's pressurized cabin.

The У-2М-IБМ amplifier is installed on the fuselage port side.

9. AUTOMATIC GUN RECHARGERS

The АП-27 automatic gun rechargers are designed for automatic recharging when firing, in case of fire stoppages which can be eliminated by recharging.

The automatic gun rechargers are installed in the gunner's pressurized cabin, one - on the port side, the other - on the starboard of the fuselage.

10. ROTARY AMPLIFIER

The БА-3Д rotary amplifier is designed for generating D.C. current for energizing the turret electric drive motor.

The БА-3Д amplifier is secured on the fuselage in the dorsal fin between frames №№ 60-61 outside the pressurized cabin.

11. AMMUNITION BOOSTER BOXES

Two АЗ-4 ammunition booster boxes aredesigned for automatic and manual control of the ammunition booster motors.

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The КЭП-4 ammunition booster boxes are installed in the gunner's pressurized cabin on the port side.

12. FIRE INTERRUPTER UNIT

The А3-1АМ fire interrupter unit is designed for automatic fire interruption at large difference in angles of the gun and the sight setting.

The А3-1АМ fire interrupter unit is installed in the gunner's pressurized cabin on the port side.

13. RANGE FINDER RADAR UNIT No.1

Unit No.1 comprises a modulator with rectifiers and a high-frequency generator. The unit is installed in the dorsal fin between the fuselage frames No.60-61.

14. RANGE FINDER RADAR UNITS Nos. 2 and 3

Unit No.2 (range unit) incorporates the range generator and the search generator; unit No.3 (power supply unit) comprises a coupling unit and unit No.3 power supply rectifiers. Units Nos.2 and 3 are installed on the fuselage framework, in the dorsal fin between frames Nos.60-61 on the common panel.

15. "Gamma" RANGE FINDER RADAR WAVEGUIDE FEEDER

The feeder is designed for connecting the transmitter to the antenna.

The feeder is made of separate links on the fuselage port side from unit No.1 to the turret.

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On frames Nos. 65 and 68 the feeder passes through special pressure seals.

16. AMMUNITION FEED LINES

The ammunition feed line, which consists of ammunition boxes, each containing 250 cartridges, and rigid chutes, is designed for accommodation and feeding the ammunition to the guns through the pressurized cabin (Fig.41).

The ammunition boxes for the right and left guns are located outside the pressurized cabin between frames Nos. 60 and 62.

Laid from the ammunition boxes to the fuselage outlet opening, on frame No. 68, are rigid chutes. At frame No.68 the rigid chutes are joined to the turret flexible chutes.

In the area of frames Nos. 65-68 the rigid ammunition feed chutes pass through the pressurized cabin in sealed ducts.

The rigid chutes consist of separate links. The ammunition is fed to the guns by ammunition boosters which are installed on the ammunition box openings and on the turret flexible chutes.

17. AMMUNITION LOADING SYSTEM

To place the ammunition belts in boxes, the fuselage has special doors with openings and the boxes are provided with manually-operated winches (Fig.44).

When raising the ammunition belt, the crank is installed on the upper shaft. The fuselage access door opens and is secured in the open position with a pin.

The winch cable is routed down through the access door and the loop (hook) of the ammunition belt last link is fastened to the cable hook (loop).

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When reeling up the cable on the winch drum, the ammunition belt rises to the lower shaft reaching the sprockets.

After the ammunition belt has been routed over the sprocket of the lower shaft, the cable is disconnected and the crank is installed on the lower shaft. The ammunition belt is placed in the boxes compartments in accordance with the loading diagram drawn on the ammunition boxes. The ammunition belt free end is drawn by a special rod through the rigid ammunition feed chutes to the turret flexible chute. Further the belt is drawn to the guns in accordance with the operating instruction.

18. TURRET FAIRING

The fairing makes the turret fall into the fuselage contour.

The turret fairing of riveted structure is attached around the contour of frame No.68.

The fairing side panels are opened to provide access to the turret units.

The turret fairing bottom is provided with the turret drives selsyns access door.

Installed on frame No.68 are the "TURRET" and "FIRE" switches, which must be switched off to ensure safety working at the gun installation.

With the fairing panels closed, the switches are automatically switched on.

19. KMC-53M SIGHTING STATION

The KMC-53M radar sighting station with the EB-257-I computer and "Gamma-5AT" range finder radar is an automatic sight used to control firing.

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When aiming the guns at a target and synchronously tracking it, the sighting station automatically introduces into the computer the following data of the target required for making the flight firing corrections by the computer:

a) the target relative angular velocities in azimuth and elevation which are introduced into the computer in the form of current values by the IP-3 rate gyros, when tracking the target;

b) target elevation and azimuth relative to the aircraft C.L. - which are introduced into the computer by KC-3 selsyn-transmitters as a turning angle of the turret drive according to the selsyn follow--up systems turn angles.

c) range of the target is introduced into the computer from the "Gamma-54T" range finder radar or from the sighting station collimator sight external - base range finding unit in the form of a voltage picked up from the potentiometer.

The range is introduced from the external - base range finding unit when the target is surrounded with a light diamonds graticule of the collimator sight reticle circle, by manually rotating the range knob.

Range of the target from the "Gamma-54T" range finder radar is introduced automatically, the external - base range finding unit is switched off (when the target is not surrounded by light circle of the sight reticle).

To control the guns firing, the sighting station is fitted with a trigger and control lever.

Aiming at and tracking of the target is performed by the gunner manually.

The KPC-53B sighting station is of a pillar-type and consists of the following parts:

a) collimator sight with a range-finding unit;

b) azimuth and elevation aiming gears;

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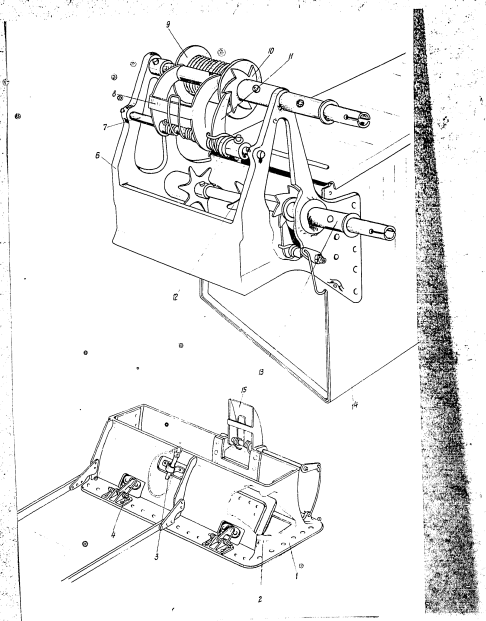

Fig. 44. Installation of Winch and Ammunition Loading Device.

1 – Opening case; 2 – door; 3 – pin; 4 – hinge pin; 5 – spring; 6 – winch casing; 7 – shaft; 8 – holding roller; 9 – drum; 10 – ratchet; 11 – dog; 12 – sprocket; 13 – shaft; 14 – ammunition box; 15 – lock.

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c) azimuth and elevation selsyn-transmitters;

d) azimuth and elevation gyros;

e) ПАЧ-457 camera gun.

КПС-53А Sighting Station Main Data

1. Range of target size (base) ..... 7-45 m.
2. Distance measuring range with an optic range finder.... ..... 200-2[illegible] m.
3. Full angular movement of the sighting station (including compression of rubber bumpers) should be:

   in azimuth: right ..... not less than 60°

   left ..... not less than 30°

   in elevation: up ..... not less than 60°

   down ..... +5°±1°
4. Operating temperature range ..... from -40°C to +60°C
5. Power supply:

   D.C. ..... 27 V ± 10%

   A.C. ..... 115 V ± 10%, 400 c.p.s.

20. ВБ-257-I COMPUTER

When solving the problems of flight firing by the computer, taken into account are:

1. Target movement relative speed.
2. Shell lag versus relative airflow.
3. Shell descent by gravity.
4. Shell spinning.
5. Distance between the sighting station and the gun installation along the aircraft C.L. (parallel horizontal base) and along the axis

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perpendicular to the aircraft C.L. in the plane of symmetry (parallax vertical base).

6. Aircraft pitching angle.

7. Influence of number of rounds and the charge temperature on the shell muzzle velocity.

The initial data for solving the problem of flight firing are introduced into the computer from the optic sighting station transmitters, "Gamma-54T" range finder radar, the air speed and density and charge temperature units.

Range of change in input data introduced into the computer are assumed as follows:

Initial range of target	R_o =200-4000m.
Target approach speed	V_n =0 - 300 m./sec.
Target azimuth	$\beta_o = 180 \pm 70^o$
Target elevation	$\varepsilon_o = 0 \pm 75^o$
Sight beam absolute angular velocity projection	W_β, W_ε =±0.3 radian/sec.
True air speed	V=250-2000 km./hr.
Outside air temperature	t=-60/+50°C
Parallax horizontal base	$B_h = \pm 25$ m.
Parallax vertical base	B_v = 0-7 m.
Shell muzzle velocity	$V_{o\,hom.}$ =700-900 m/sec.
Charge temperature	$t^o_{ch.}$ =-60 to +50°C.

21. "Gamma-54T" RANGE FINDER RADAR

The "Gamma-54T" range finder radar is designed to introduce values of range to the target and target approach speed into the EB-257-I computer and to send audio signals to the T.C.S. when the target is locked (detected) or approached at a fire distance.

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The range finder radar principle of operation is based on measuring the time required for the electromagnetic energy pulse to radiate from the range finder radar antenna to the target and back.

RANGE FINDER RADAR TACTICAL DATA

1. Range finder radar operating range (against a fighter) ..... not less than 1900 m.

2. Detection and tracking of a target by range finder radar is performed at a distance not less than 2000 m.

3. Target locking is indicated by the green light illumination and continuous audio signal, 400 c.p.s. I.C.S.

Target approach to aimed firing distance (1900 m.) is indicated by the red light illumination and intermittent audio signal, 400 c.p.s., I.C.S.

When the target is locked, the sight is automatically changed over from the external-base range finding unit to automatic introduction of range and target approach speed from the range finder radar.

3. With the target relative approach speed of 0 to 200 m./sec. the range finder radar generates a voltage proportional to the approach speed and changing within the range of 0 to 100 volts.

4. Range finder radar min. operating zone (dead zone) ..... not more than 180 m.

5. Max. error in range determinating at a distance of 300-1900 m. does not exceed ±5 m.

6. The range finder radar antenna radiation field ensures directing aimed fire using the [redacted] sight and with the max. prediction angle not more than 10°.

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7. If several targets simultaneously get in the range finder radar radiation field, the automatic tracking system is locked on the nearest target; the target can also be selected by switching the "NEAREST--DISTANT TARGET" toggle switch.

22. GUN RECHARGING PNEUMATIC SYSTEM

To perform electropneumatic recharging of the guns, the turret is provided with АП-27 automatic rechargers.

Installed on frame 62 are two bottles charged with air to a pressure of 150 atm. on the ground. From the bottles the air passes via the reducing valve into the low pressure (65 atm.) bottle, installed on the turret, and from it into the gun recharging cylinder via the electro-pneumatic valve. The air in the pneumatic recharging system past the reducing valve is checked for presence by the МВ-250М pressure gauge installed on the gunner's cabin starboard.

Pneumatic gun recharging is accomplished by pressing the recharging buttons located on the ОП-54Т main control panel. In this case the АП-27 automatic recharger is actuated and sends a pulse to the ЭК-48 electro-pneumatic valve, and the air enters the gun recharging cylinder.

II. BOMBING ARMAMENT

The aircraft is provided for carrying four photo-flash bombs, 100 kg. each, and six colour-illuminating bombs, 10 kg. each.

Two 100 kg. bombs are suspended in the external bomb racks under the L.G. fairings nose parts and two bombs on the bomb racks in the L.G. fairings rear parts bomb bay.

10 kg. bombs are suspended in a АБ-СС-АТ bomb magazine installed in the rear fuselage in the area of frames Nos.62-64,

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To carry-out aimed obmbing ,a НКПБ-7 bomb sight is installed in the nose fuselage , in the navigator's cabin.

1. EXTERNAL BOMB RACK.

The external bomb rack (Fig.45) comprises four walls of duralumin sheets, riveted into the fairing framework and surrounding the ЗА-2 latch,sway braces,ПБД-48 drive, МВН-48 "ACTIVE-PASSIVE" mechanism and ДЕР2-47 shackle.

Installed on the ЗА-2 latches shaft is the latch position indicator; when the latches are opened the indicator rod pin extends beyond the rack, with the latches locked, the pin moves inside the rack.

The bombs are lifted by a special hook.

2. INTERNAL BOMB RACK .

The internal bomb rack installed in the bomb bay of L.G. fairing rear part (Fig.46) consists of a casing (2),sway braces (3), ЗА-2 latches,ПБД-45 drive, МВН-48 "ACTIVE-PASSIVE" mechanism and ДЕР2-47 shackle.

Installed on the rack casing is a bracket with a pulley for lifting the bombs. To provide a good access to the ДЕР2-47 shackles, when removing the bombs, the bracket with the pulley is made easily detachable.

Installed on the ЗА-2 latches shaft is the latches position indicator.

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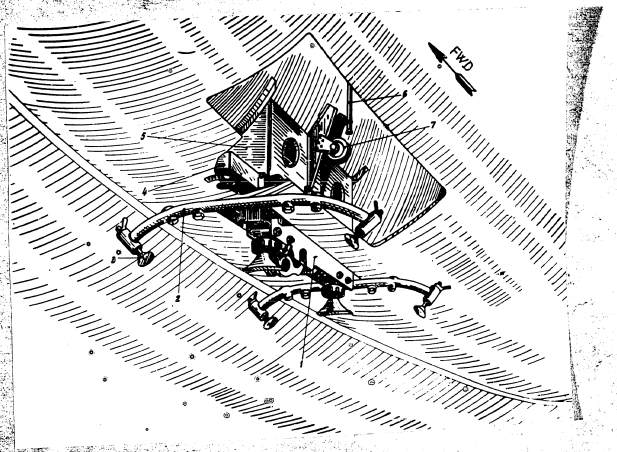

Fig. 49. External Bomb Rack

1 - ДЕР2-47 shackle; 2 - sway brace; 3 - stop; 4 - ПБД-48 drive; 5 - rack; 6 - guide tube for lifting cable; 7 - pulley.

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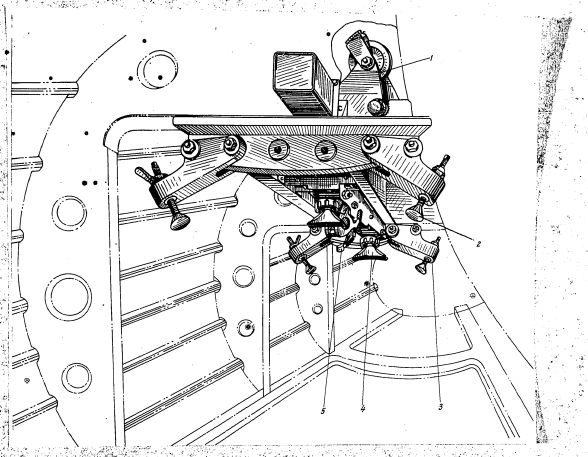

Fig. 46. Internal bomb rack.

1 - lifting pulley; 2 - stop; 3 - stop bracket; 4 - AEF2-47 shackle; 5 - latch arm.

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3. ДЯ-СС-АТ BOMB MAGAZINE

The ДЯ-СС-АТ bomb magazine is installed in the rear fuselage bomb bay at frames Nos.62-64, by two front brackets (2) and rear bracket (1) (Fig.47).

The front bracket is provided with a shackle which consists of a stop (4), handle (3) and guide (5). The ДЯ-СС-АТ bomb magazines front pins enter the lock guide (5), which is turned by the handle (3) and secured with the stop (4).

The magazine rear lug enters the bracket (1) fork and is secured in it with a pin.

The ДЯ-СС-АТ bomb magazine is designed for accommodation and dropping of colour illuminating bombs.

TECHNICAL DATA

1. Max. number of bombs to be loaded - 6 ea.
2. Bombs are released only at "ACTIVE".
3. "COMBAT" bomb release is performed singly.
4. Bomb release control and warning system indicating bombs presence in the bomb magazine are remote-controlled electrically from the ПУ-СС-АТ control panel.
5. Bomb release is accomplished by the ПБД-48 electro-mechanical drives; each bomb is dropped by its drive.
6. Warning about bombs presence in the magazine is performed by the closed contacts of each ПБД-48 drive.
7. In emergency all the bombs are released simultaneously through the drives interlocking contacts.
8. ПБД-48 drives operating voltage ..... 27 ± 2 V
9. Min.voltage for ПБД-48 drives ... 16 V

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The magazine rear lug enters the bracket (1) fork and is secured in it with a pin.

The ДЯ-СС-АТ bomb magazine is designed for accommodation and dropping of colour illuminating bombs.

TECHNICAL DATA

1. Max. number of bombs to be loaded - 6 ea.
2. Bombs are released only at "ACTIVE".
3. "COMBAT" bomb release is performed singly.
4. Bomb release control and warning system indicating bombs presence in the bomb magazine are remote-controlled electrically from the ПУ-СС-АТ control panel.
5. Bomb release is accomplished by the ПБД-48 electro-mechanical drives, each bomb is dropped by its drive.
6. Warning about bombs presence in the magazine is performed by the closed contacts of each ПБД-48 drive.
7. In emergency all the bombs are released simultaneously through the drives interlocking contacts.
8. ПБД-48 drives operating voltage ..... 27 V ± 10%
9. Min.voltage for ПБД-48 drives ... 16 V

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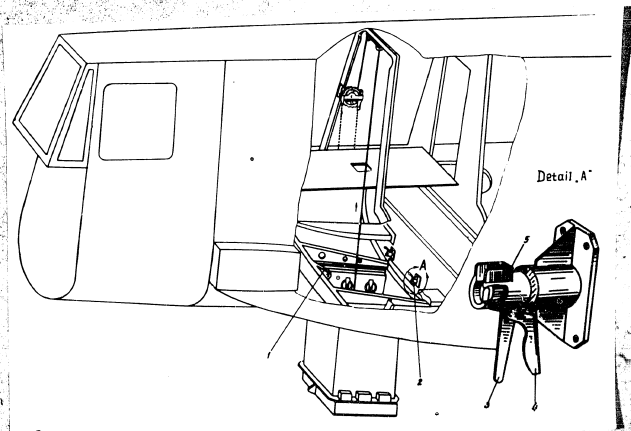

Fig. 47. ДБ-СС-АТ Bomb Magazine Lifting Diagram

1 - Rear bracket; 2 - front bracket; 3 - handle; 4 - stop; 5 - guide.

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10. Current drawn by one ПБД-48 drive at a voltage of 24 v and ambient air temperature of 20°C for combat bombing... not more than 6A.

NOTE: Measure voltage and current across the ПБД-48 drives plug connectors pins.

BOMB MAGAZINE DESIGN

The ДЯ-СС-АТ (Fig.48) bomb magazine is a framework riveted of duralumin sheets and sections, divided into six vertical wells which contain bombs. Each well contains one bomb.

The lower part of the bomb magazine framework is edged with the reinforcing collar (17), which is a frame of magnesium casting, the upper part of the bomb case framework - with the collars (6) and (4).

The wells bottoms and the control levers are secured to the bottom collar by brackets.

A bomb is placed on the bottom (21) in the vertical position. The bottom is hinged, rigidly attached to it is the lever (18) with a roller. The lever roller rests against the flat of the intermediate lever (20) which is connected through the fork (19) to the ПБД-48 drive pin.

When the drive actuates the pin pushes the fork connected to the intermediate lever, the lever turns and disengages with the bottom lever roller. By the bomb weight the bottom turns and the bomb is released from the well.

The roller is placed on the bottom lever to decrease friction.

Installed on the bottom collar on either side of the bomb magazine are ПБД-48 drives designed for opening the bottoms. Marked on the bomb magazine side walls against each drive are figures indicating the sequence of the ПБД-48 actuation.

The bottom collar side is covered with the casing (1) which

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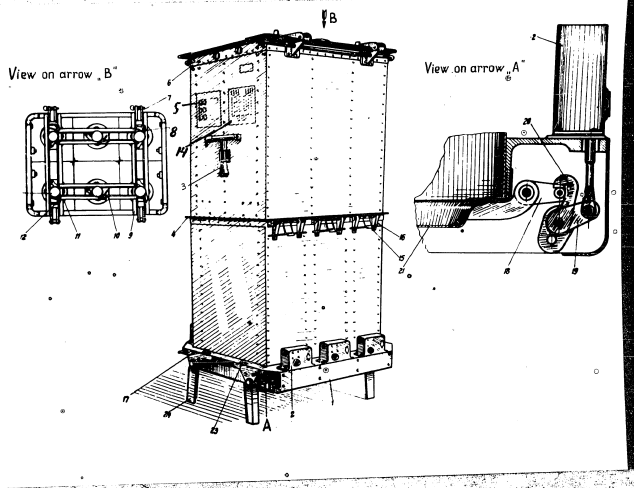

Fig. 48. ПЯ-СС-АТ Bomb Magazine

1 - Casing; 2 - ПБД-48 drive; 3 - key for cocking ПБД-48 drive; 4 - middle collar; 5 - bomb magazine loading instruction plate; 6 - top collar; 7 - lugs; 8 - spring; 9 - hinged cover; 10 - bracket; 11 - holder; 12 - lever; 13 - mushroom; 14 - wiring diagram plate; 15 - flag; 16 - catch; 17 - bottom collar; 18 - lever; 19 - fork; 20 - intermediate lever; 21 - bottom; 23 - lever; 24 - leg.

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protects the bottom control levers from damage.

To place the bomb magazine on the ground, it is fitted with four legs (24) which are retracted by a spring to be flush with the collar lower edge after the bomb magazine is lifted to the aircraft.

The legs are held in the extended position by means of the lever (23) secured on the collar. To retract the leg, turn the lever (23) in the direction opposite to that of the leg turn.

The legs are painted red. Secured on the top collar by the bracket is the hinged cover (9).

Installed on the cover along each well axis are holders to prevent the bombs vertical displacement. The cover is secured in the lugs (7) by a pin.

The holder consists of the cast bracket (10) secured in which are the mushroom (13) resting against the bomb end and tube with the disc restricting the bomb displacement in vertical direction.

Annular grooves of taper section are cut on the holder tube. The grooves serve for securing the holder at the required height. The holder upward movement is restricted by the lever (12) whose tooth enters the annular groove and prevents the holder from moving upward.

The spring (8) holds the lever in the operating fixed position.

Warning about bombs presence in the bomb magazine is accomplished by the contacts of each ПЭП-48 drive. The warning system wire is attached to the terminal (3).

After releasing the bombs (drive combat actuation) the drive contacts are changed over and break the warning circuit/indicating that the bomb is dropped from the well.

The parachute lanyard is pulled out, when "active" releasing the bomb by the spring hooks secured in the upper part of the well inner wall.

The loaded bomb magazine is lifted to the aircraft by means

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the winch. The winch cable is secured in the socket installed on the bomb magazine middle wall.

4. ПУ-СС-АТ CONTROL PANEL

The ПУ-СС-АТ control panel is designed for remote electric control of the bombs release from the АЗ-СС-АТ bomb magazine.

The ПУ-СС-АТ control panel is installed on the navigator's right switch panel.

On the control panel face is a switch which ensures power supply from the aircraft electrical system to the control panel and the bomb magazine electrical circuit.

Above the "POWER" switch is a САЦ-5 warning light which comes on, with the 2Б-45 switch set in the "bombs" position, thus indicating that power from the aircraft electrical system is supplied to the bomb magazine.

Also installed on the panel are the ПН-45М bomb doors control selector switch and two САЦ-5Г warning lights indicating the bomb doors position. The ПН-45М bomb doors emergency control selector switch and the 2Б-45 selector switch of the bombs emergency release from the bomb magazine, which are located on the control panel, are covered with protective caps painted red.

Below the control panel are six 205-К2 bomb release buttons arranged in row(corresponding to the number of walls in the bomb magazine), above each button is a САЦ-5Г warning light indicating the bomb presence in the bomb magazine wall.

The bombs release control electric circuit ensures both normal and emergency bomb release only at "ARMED", but warning about the bombs presence in the magazine.

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5. BOMB LIFTING SYSTEM

100 kg. bombs are lifted to the bomb racks as follows. Installed on the L.G. fairing rear section side is the lifting frame which is placed on the tubular rod installed between the L.G. fairing frames Nos.34-35. The frame bottom is attached by a quick-disconnecting fitting in the L.G. fairing special recess.

Attached on the lifting frame is the БЛ-47 winch. The winch cable is routed around the frame pulleys and through the pulley of the proper bomb bay (Fig.49) is connected to the ДЕР2-47 shackle attached to the bomb casing by means of a special hook. The bombs are lifted to all the four bomb racks by the same lifting frame.

After loading the bombs on one side of the fuselage move the frame to the other side.

The frame is installed at the rear bomb bay of both L.G. fairings.

Above the bomb racks in the L.G. fairings are removable access doors to permit the cable entering the fairings.

In the rear bomb bays the winch cable is routed around the pulley installed on the bomb rack. The БЛ-47 winch cable passes over additionally installed pulleys to the front bomb racks.

The ДЯ-СС-АТ bomb magazine loaded with bombs, is lifted by means of the ДЯ-СС-СБІ winch installed at frame No.63.

The winch cable routed around the pulleys is inserted into the ДЯ-СС-АТ bomb magazine lifting bracket.

With the winch rotating by means of the ball-type chain the bomb magazine is lifted to the bomb bay and is attached by brackets.

To load the ДЯ-СС-АТ bomb magazine, use a ladder which is placed under the bomb bay.

The ДЯ-СС-СБІ winch is installed at frame No.62 by means of special brackets.

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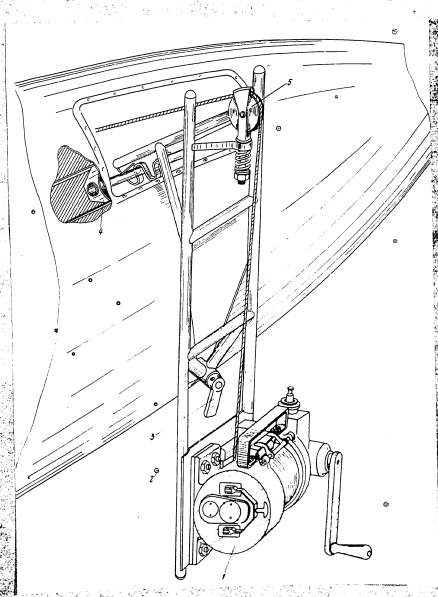

Fig. 49. EL-47 Winch Installation

1 - EL-47 winch; 2 - frame; 3 - lock; 4 - upper frame winching bracket; 5 - guide pulley.

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The winch cable is routed around the pulleys placed in cast magnesium brackets.

The brackets are bolted to frame No.63 and a special diaphragm .

6. MKMB-7 BOMB SIGHT INSTALLATION

The bomb sight is installed in the navigator's compartment on a special cast magnesium bracket. The bracket has a vertical axis of rotation, which permits the navigator to set the bomb sight in the stowed position without removing the sight from the bracket. The sight bracket is locked in the operating and stowed positions by a special handle.

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[redacted]

AIRCRAFT RANGE FINDER

TYPE CD-IM

DESCRIPTION AND SERVICE INSTRUCTIONS

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AIRCRAFT RANGE FINDER

TYPE СД-1М.

Description

and

Service Instructions

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p.p.

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PART I.

DESCRIPTION OF TYPE [illegible] RANGE FINDER

Chapter I.

General

1. Designation and Principal Parts of Type [illegible] Range Finder

The type [illegible] range finder is designed for operation on aeroplanes and serves for:

a) indicating on a plane the distance to the aerodrome where it is to land, or to any other aerodrome equipped with a type [illegible] responder beacon;

b) ensuring piloting of a plane when circling around the aerodrome on which it is to land;

c) indicating on a plane the [illegible] to the point of landing when the plane is on its landing course.

Besides this the range finder permits calculation of the speed of approaching an aerodrome, the time remaining until the aerodrome to be landed on will be reached, and also helps to solve a number of other navigation problems.

The range finder is an instrument for short-distance navigation and blind landing. It is designed for use together with other aircraft equipment for blind landing, but it may be installed on a plane which has no equipment of this kind.

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PART I.

DESCRIPTION OF TYPE CA-1M RANGE FINDER

Chapter I.

General

1. Designation and Principal Parts of Type CA-1M Range Finder

The type CA-1M range finder is designed for operation on aeroplanes and serves for:

a) indicating on a plane the distance to the [illegible] where it is to land, or to any other aero[illegible]d with a type CA-1M responder beacon;

b) [illegible]suring piloting of a plane [illegible] the aerodrome on which it is to land;

[illegible] to [illegible] landing when the plane is on its landing [illegible].

[illegible] this the range finder [illegible] approaching an aerodrome, [illegible] until the aerodrome to be la[illegible] will [illegible] also helps to solve a number of other [illegible] lens.

The range finder is an instrument for [illegible] navigation and blind landing. It is [illegible] together with other aircraft equipment for blind [illegible], but it may be installed on a plane which has no [illegible] of this kind.

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[redacted] Range Finder Function together with type [redacted] ground responder beacon.

The range finder consists of a transmitter and power supply unit, a receiver and time selector unit, a distance and circling course indicator, a control panel, sending and receiving antennas, cables and feeders.

A. Operating Principles of the Type [redacted] Range Finder

The determination of the distance from a plane to an aerodrome provided with a responder beacon is based on measuring the time spent by pulse radio signals to cover the distance from the plane to the beacon and back. To promote understanding of the operating principles of the range finder it is necessary to consider its work together with that of a responder beacon (see sig.1).

Diagram of the type [redacted] range finder and the type [redacted] responder beacon units is shown in Fig.2.

The transmitter of the range finder is connected through a high frequency feeder to a sending antenna, which radiates twin pulses with a frequency of [redacted] cps, corresponding to a time delay between successive twin pulses of 10,000 microseconds. Each pair of pulses, in turn, comprises two pulses each with a duration of about 1 microsecond. The time delay between the fronts of the pulses is 2, 4 or 6 microseconds, which corresponds to the 1st, the 2nd and the 3rd communication channels between the plane and the ground.

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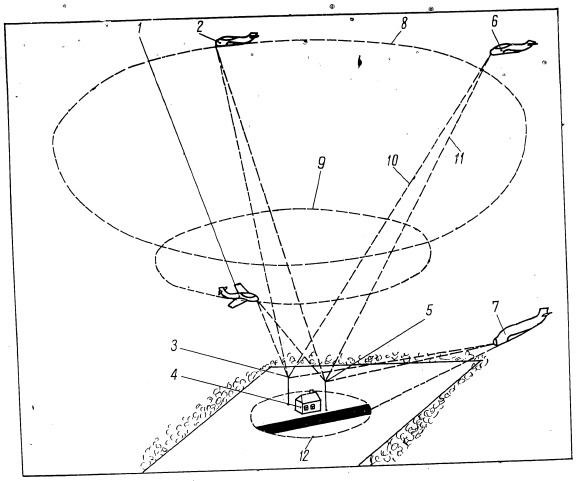

Fig.I. Operating Principles of the СД-IM, РД-I System.
1 - a plane on the minimum circling course (9 km) around the aerodrome on which it is to land, 2 - a plane on the maximum circling course (19km) around the aerodrome, 3 - receiving antenna of the responder beacon, 4 - responder beacon, 5- sending antenna of the responder beacon, 6 - a plane interrogates the beacon and determines the distance to the aerodrome, 7 - a plane on the landing beam checks the distance to the point of landing, 8 - 19 km circling course, 10 - interrogations, 11 - response, 12 - zero circle.

Fig.I Page 4a.

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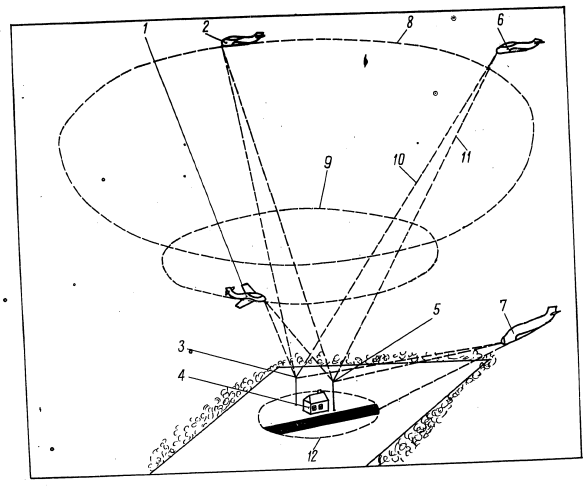

Fig.I. Operating Principles of the СД-IM, РД-I System.

1 - a plane on the minimum circling course (9 km) around the aerodrome on which it is to land, 2 - a plane on the maximum circling course (19km) around the aerodrome, 3 - receiving antenna of the responder beacon, 4 - responder beacon, 5- sending antenna of the responder beacon, 6 - a plane interrogates the beacon and determines the distance to the aerodrome, 7 - a plane on the landing beam checks the distance to the point of landing, 8 - 19 km circling course, 10 - interrogations, 11 - response, 12 - zero circle.

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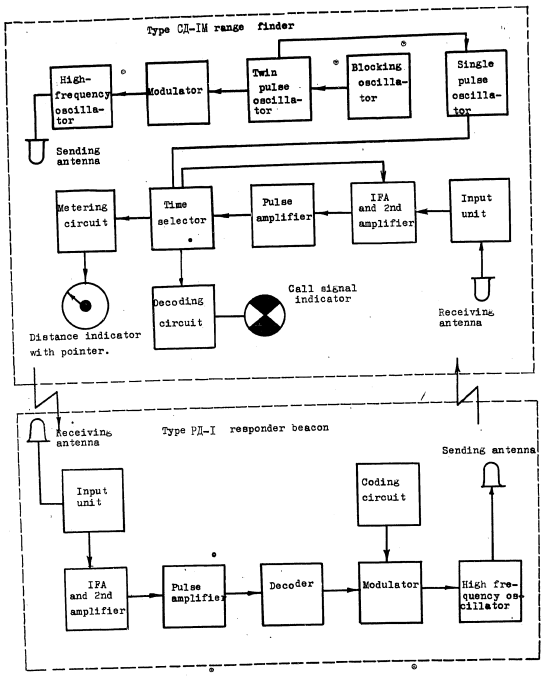

Fig.2. Schematic diagram of the type СД-IM range finder and the type РД-I responder beacon.

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The pulses radiated by the transmitter of the range finder when operating on the 1st, 2nd and 3rd communication channels are shown in Fig.3.

The twin pulses radiated by the aeroplane transmitter (the so-called interrogation pulses) are received by the receiver of the ground responder beacon. The receiver has a decoder that selects only those twin pulses which correspond to the communication channel it is tuned to. The decoder also transforms the twin pulses into single ones corresponding in time to the second pulses of each pair. These single pulses modulate the transmitter of the ground responder beacon, which radiates response signals through its sending antenna. Therefore the ground beacon responds only to those aircraft range finders that operate on the same communication channel.

The response pulses are received by the range finder receiver of the plane, are then amplified on intermediate and low frequencies and delivered to the inputs of the selecting and metering circuits of the range finder. Single starting pulse is also sent to the input of these circuits from the transmitter. This single pulse is received simultaneously with the second pulse of a pair.

The starting pulses of the range finder and the response pulses of the ground beacon will be received at the selector-metering circuit input with a shifting in time t. This time lag (t) consists of the time required for the signal to cover the distance from the plane to the beacon and back and [illegible] required for [illegible]

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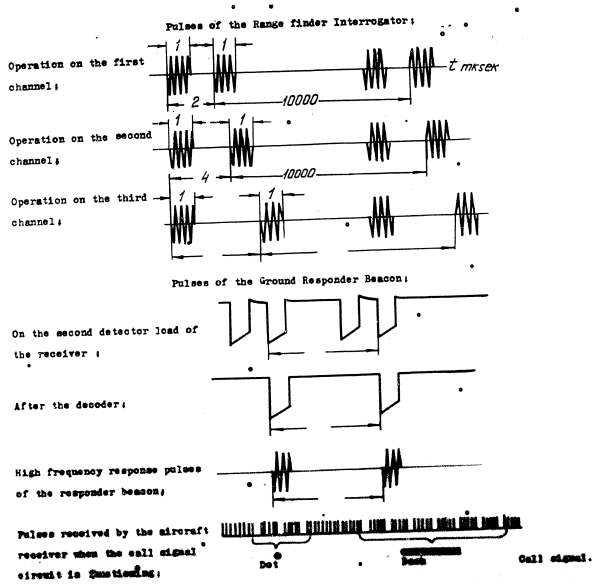

Fig.3. Form of the Interrogation and Response Pulses.

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receiver-transmitter of the beacon (t_1) and through the receiver-transmitter of the range finder (t_2). As the above values, as well as the velocity of radio wave propagation (g), are constant, then the time lag will be proportional to the distance (D) from the plane to the ground responder beacon.

$$t = \frac{2D}{C} + t_1 + t_2$$

The metering circuit of the range finder generates a voltage proportional to the time lag between the interrogation and the response pulses and actuates the distance indicator, which is a d.c. instrument with its scale calibrated in km.

In this way the distance from the plane to the aerodrome where the responder beacon is located is measured.

Circling flight is observed by corresponding tuning of the range finder detecting circuit, upon which the pointer of the distance indicator will be at the centre of the scale bearing the mark zero. If the aircraft will deviate from a circling course with a responder beacon set in its centre, the pointer will also move from the zero position. In this instance a deviation of 500 to 600 metres will cause the pointer to move to the right of the mark from zero up to the 0.5 graduation.

The ground responder beacon can reply to lateral (up to 45°) aircraft range finders. Therefore a set of response signals will be received at the input of the receiver.

These pulses may disturb normal flight of the aircraft

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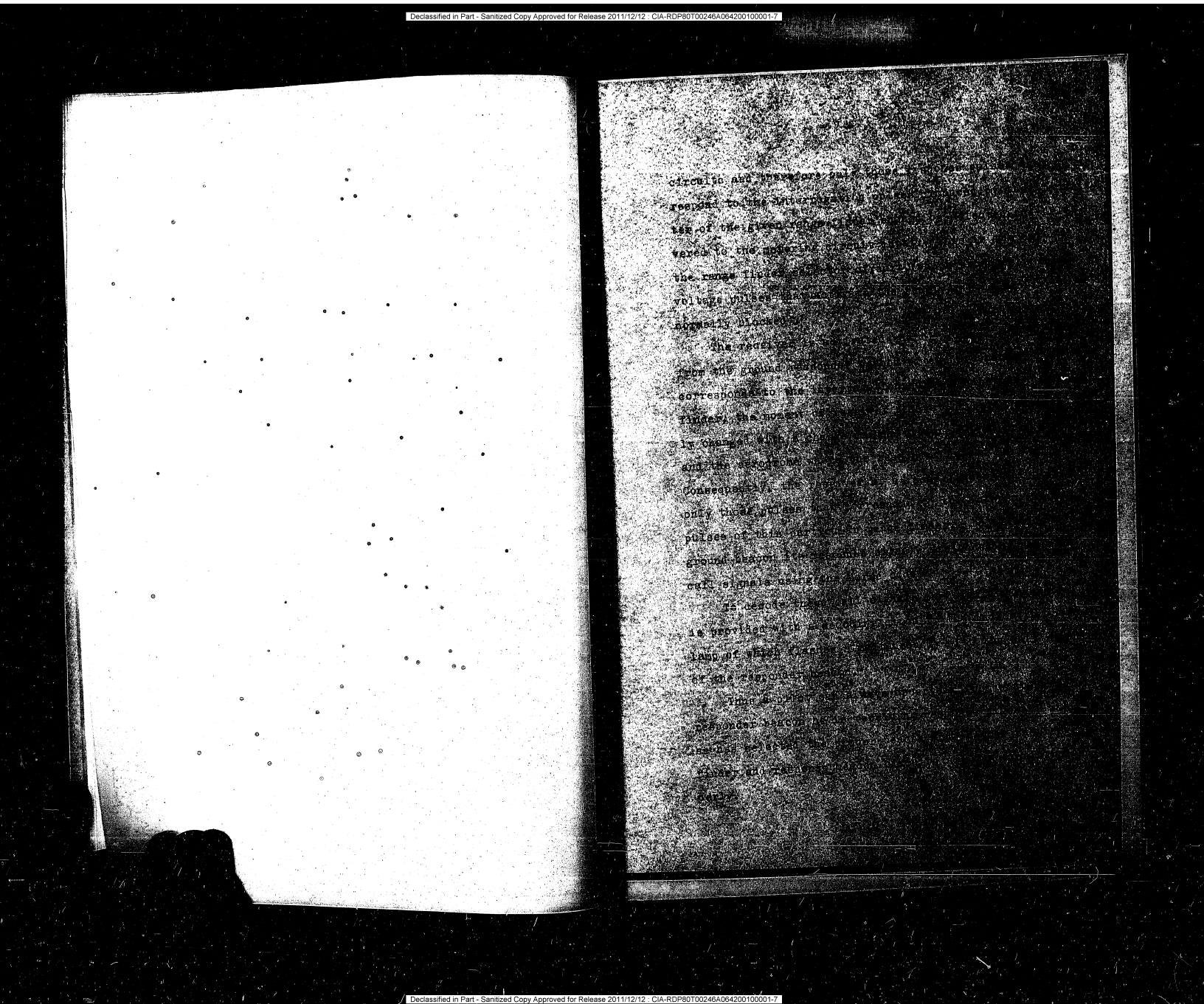

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3. Principal Parts and Units

The type СД-1М range finder includes:

A. Operating Units

1. Transmitter and power supply unit	1
2. Receiver and selector unit	1
3. Distance and circling course indicator	1
4. Control panel	1
5. Type MA-250M motor-alternator	1
6. Receiving antenna	1
7. Sending antenna	1
8. Connecting cables and feeders:	
a) cable from the type MA-250M motor-alternator to aeroplane mains (1)	1
b) cable from the type MA-250M motor-alternator to transmitter (2)	1
c) cable from the transmitter to receiver (3)	1
d) cable from the receiver to control panel (4)	1
e) cable from the control panel to distance indicator (5)	1
f) feeder from the receiver antenna to receiver (6)	1
g) feeder from the sending antenna to transmitter (7)	1

B. Spare Equipment

A box with spare tubes and tools	1 set

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4. Designation of the Type [illegible]
Aircraft Range Finder Units and Their Arrangement

1. The transmitter and power supply unit is designed for producing high frequency interrogation pulses that are then sent from required feeding voltages.

2. The receiver and selector unit consisting of a receiver, a time selector, a metering circuit, a circling course circuit and a decoding circuit is designed for receiving the response pulses of the responder beacon, which correspond to the interrogation pulses of the given range finder, for producing a voltage that is proportional to the distance from the plane to the aerodrome, and for decoding the call signals of the responder beacon.

3. The distance and circling course indicator is the output instrument of the range finder and is designed for direct reading in km of the distance between the plane and the aerodrome and for indicating the circling course of the plane.

4. The control panel is designed for switching on the range finder, for connecting the required communication channels and for checking and controlling the accuracy of calibration of the distance and circling course indicator scales.

5. The type MA-250M motor-alternator is designed for producing a voltage of 115 v at 400 cps.

6. The receiving antenna is intended for receiving the response pulses from the beacon and for delivering them

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to the input of the receiver.

7. The sending antenna is designed for radiation of the high frequency interrogation pulses produced by the range finder.

8. The connecting cables and feeders serve for connecting the separate units and parts of the range finder to each other and to the power supply unit.

9. The transmitter and power supply unit, the receiver and selector unit and the type NA-250M motor-alternator are arranged in the plane fuselage at special places near the sending and receiving antennas.

The sending and receiver antennas are mounted on the lower surface of the plane fuselage.

The distance and circling course indicator is mounted on the pilot's instrument panel. The control panel is installed in the pilot's cabin. A diagram of how to connect the units and their dimensions are given at the end of the book in the installation and dimension diagram (see Fig.).

5. Design of the Parts and Units of the Type CA-1M Aircraft Range Finder

1. Transmitter and Power Supply Unit

The unit is mounted on a shock-absorbing support and is secured thereon with two screws.

All the parts of the transmitter are assembled on a horizontal chassis having a bend that divides the transmitter into two parts. One part contains the tubes and parts of the power unit, the other -- those of the transmitter.

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Under the chassis there are component boards with [illegible] of the circuit. On the front panel there [illegible] following jacks:

a) "Power supply" ("Питание") for connecting the [illegible] to the type MA-250M motor-alternator;

b) "Receiver" ("Приемник") for the cable [illegible] the receiver to the transmitter;

c) a high frequency jack "Sending antenna" ("[illegible] ная антенна") for the feeder connecting the [illegible] the antenna.

Besides this the front panel has [illegible] 27 v, 115 v 400 cps circuits and for the [illegible] H.V. rectifier; two terminals for checking the [illegible] 400 cps current, a lock-nut and the [illegible] meter serving to set a voltage of 115 v 400 cps.

The front panel is also provided with a [illegible] closes the opening necessary for tuning the oscillator frequency.

Two handles are secured to the front panel to facilitate carrying of the transmitter from one place to another.

2. Receiver and Selector Unit

The receiver and selector unit is counted on a shock absorbing support and is secured thereon with two [illegible] screws.

All the parts of this unit are assembled on a horizontal chassis. On the top of the chassis are installed

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tubes, relays, circuits of the intermediate frequency amplifier, a thermo-compensation unit, a heating transformer, wire resistors and blocking capacitors. Under the chassis there are component boards with elements of the circuit, the high frequency input unit of the receiver and wire-wound resistors.

The front panel of the receiver is provided with the following jacks:

a) "Transmitter" ("Передатчик") for the cable connecting the receiver to the transmitter.

b) "Panel" ("Щиток") for the cable connecting the receiver to the control panel.

c) A high frequency jack "Receiving antenna" ("Антенна приемная") - for the feader, connecting the receiver to the receiver antenna.

The front panel of the unit also has two caps closing two openings, the right-hand one being designed for tuning the receiver heterodyne, the left-hand one - for tuning the detector.

Besides this the front panel has two potentiometers for tuning the circling courses.

The front panel is also provided with two handles to facilitate transportation of the unit.

3. Control Panel

On the control panel there are concentrated the following range finder controls:

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1. A handle "Range finder" ("[illegible]") for switching on the range finder and connecting the required communication channel.

2. A handle "Circling courses" ("[illegible]") for setting either of the six circling courses.

3. A knob "Adjustment" ("[illegible]") for switching over the range finder from one responder beacon to another one operating on the same communication channel.

4. A knob "Zero setting" ("Установка нуля") for checking and correcting the initial zero graduation of the distance indicator scale.

5. A knob "[illegible] setting" ("Установка [illegible] – [illegible] км") for checking and correcting the last graduation of the distance indicator scale ([illegible] when operating on the first range [illegible] when operating on the second one).

6. A knob "Circling course setting" ("Установка [illegible]") for checking and correcting the circuit of the circling course indicator.

7. A [illegible] "Call signal" ("[illegible]") for [illegible] the call [illegible] of the ground responder beacon.

8. A signal lamp [illegible] ("Включено") for indicating that the range finder is switched on.

The handle for switching on the range finder simultaneously serves for setting the required communication channel. The extreme left-hand position of the "Range finder" handle corresponds to the off position of the range finder

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and the three other positions - to the "On" position for operation on one of the three communication channels.

The handle "Circling courses" has six positions which correspond to six different circling courses.

The knobs of all three buttons of the control panel are connected to corresponding potentiometers of the circuit, it being possible to rotate the axles of the potentiometers with these handles only after pressing them down toward the panel.

The signal lamps have a rotating housing which is designed to increase or reduce the lighted area, as preferred by the pilot. The neon lamps are easily removed after removing (screwing out) the cap of the holder.

All inscriptions on the control panel are applied with fluorescent paint. The control panel is connected to the receiver and the distance indicator.

4. Distance Indicator

The distance indicator housing contains two handles: "Range" ("Диапазон") and "Kind of operation" ("Род работы"). The "Range" handle serves for going over from one distance range to another. When this handle, which is connected to a switch, is turned the selector circuits are switched over. Simultaneously with the change in the range the figures on the scale also change. When operating on the first range the whole scale corresponds to 30 km, while on the second range it corresponds to 150 km. The scale of the first range has 0, 10, 20, and 30 km marks, while the scale of the second range - 0, 50, 100, 150 km.

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The handle "Kind of operation" serves for transferring from distance indication to circling course indication and vice versa. When this handle, which is connected to a switch, is turned the circuits of the selector are switched over. Simultaneously the inscription on the lower part of the scale is changed. When the distance is being measured the inscription "km" ("КМ") will appear, while when the circling courses are being shown the inscription "Circling course" ("ОРБИТА") will be seen.

For circling flight the indicator has a special circling course scale. This scale has a mark "▽ ", at the middle of the distance scale and two arcs to the left and the right of it.

All figures and marks on the scale are made with fluorescent paint.

5. Range Finder Antennas

The sending and receiving antennas are similar in size and design. They are made of a brass silver-coated plate contained in a fairing made of an insulating material. This fairing is secured to a disk support.

6. Motor-Alternator Type MA-250M

The motor-alternator has two jacks. The conductors from the plane mains are inserted into one of them (marked "+" and "-") and the cable from the range finder transmitter is inserted into the other one. The motor-alternator is mounted on a shock-absorbing support which is screwed with four bolts to the bay-plate when being installed in a plane.

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6. Principal Tactical and Technical Specifications

The operation of the type [illegible] aircraft range finder is based on the pulse method of distance measurement. The instrument has the following principal specifications:

1. Two Kinds of Operation

a) distance measurements - indication of the distance between the plane and an aerodrome provided with a type [illegible] responder beacon;

b) circling course indication - indication of circling courses around the aerodrome to be landed on that is equipped with a type [illegible] responder beacon.

2. Indication of Distance

The aircraft range finder insures indication of the distance (according to a pointer indicator) from the plane to an aerodrome - more precisely to a circle, at the centre of which a type [illegible] responder beacon is located and which passes through the beginning of the landing path (through the point of landing).

Thus when a plane is on the landing beam the distance to the point of landing on the landing strip is indicated.

3. Operating Range

The operating range - the maximum reliably measured distance to an aerodrome equipped with a responder beacon - depends up on the altitude of a flight. At an altitude of 5000 m the maximum measurable distance is up to 150 km. At

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lower altitudes this range decreases. Thus, at an altitude of 1000 m the measurable distance is up to 80 - 90 km.

4. Ranges of Measurement

The distance is measured by means of two ranges:

a) the first range is for distances from 0 to 30 km;

b) the second range - from 10 to 150 km.

The range finder distance indicator has two scales corresponding to the above ranges:

a) the first scale is for short distances from 0 to 30 km;

b) the second scale is for long distances from 10 to 150 km.

5. Accuracy of Readings

The accuracy of readings (the maximum possible error) measured by the range finder under normal operating conditions is as follows:

a) when employing the first range the error does not exceed 600 m ± 2 % of the distance being measured;

b) when employing the second range the error does not exceed 3000 m ± 2 % of the distance being measured.

Under adverse weather conditions (rain, [illegible]) the maximum error may increase:

a) when employing the first range [illegible] of the distance being measured;

b) when employing the second range [illegible] the actual distance.

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6. Indication of Circling Courses

The aircraft range finder can ensure blind flight of a plane around an aerodrome on circular courses according to its zero-indicating pointer while waiting for its turn to land. Six circling courses can be indicated with their centre at the spot where the responder beacon is located. These courses (with an inclined radius) are at a distance of 9, 11, 13, 15, 17 and 19 km from the circle up to which the distance is indicated.

7. Accuracy of Circling Course Readings

The accuracy of circling course readings (the maximum possible error) is as follows: not over ± 250 m for 9 to 19 km courses and not over ± 250 m for 17 to 19 km courses under normal weather conditions; not over ± 450 m for 9 to 15 km courses and not over ± 450 m for 17 to 19 km courses under adverse weather conditions.

8. Indication of Distance and Circling Courses

The distance and the circling courses are indicated with the aid of a single pointer indicator having a standard housing diameter of 70 mm.

9. Communication Channels

The aircraft range finder ensures operation on three different communication channels by coding the twin interrogation pulses. Use of a number of simultaneously operating type P-4 responder beacons located at different aerodromes tuned to different communication channels and at a

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[illegible] from the [illegible] is [illegible] by [illegible] "Communication channel" [illegible] a time not exceeding 6 seconds.

10. Indication of Responder Beacon Call Signal

When distance indications are stable the range finder [illegible] indication of the call signal of the [illegible] beacon to which the distance is being shown. This is [illegible] with the aid of a neon lamp which lights [illegible] the call signals using [illegible].

11. Operation together with other Aircraft Range Finders

The type [illegible] range finder ensures [illegible] of distances and circling courses during [illegible] operation of the responder beacon with other aircraft range finders if their number does not exceed [illegible].

12. Operating Frequencies

The transmitter and the receiver of the range finder [illegible] on different frequencies.

13. Range Supply

The range finder is powered from a type [illegible] alternator, which is connected to the mains of the [illegible] with a voltage of 27 v. The motor-alternator generates an alternating current at 115 v and [illegible] cps.

Fluctuations of the mains voltage should not exceed + 2.7 v or - [illegible] v.

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The total power consumption [illegible]
720 w. (for a 115 v 400 cps [illegible]

The range finder can also be [illegible]
115 v 400 cps motor-alternator set [illegible]
direct current mains.

Fluctuations in voltage of the [illegible]
must not exceed ± 3 %.

In this case the total power required [illegible]
mains does not exceed 30 w, and that the [illegible]
400 cps motor-alternator 275 va.

14. Control of the [illegible]

All the controls of the range finder [illegible]
on the control panel and the pilot's [illegible]

15. Checking of [illegible]
in Flight.

The circuitry and [illegible]
it possible to check [illegible]
in flight. This is done [illegible]

16. [illegible]

Indication of the distance [illegible]
the range finder at altitudes [illegible]
10,000 m. At greater altitudes [illegible]
automatically adjusts [illegible]
of 10,000 m. [illegible]
its operation.

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17. Interchangeability

The range finder continues to function normally when any of its units, antennas, cables, or the high frequency feeder is replaced. The replacement of the transmitter, receiver, control panel or the high frequency feeder requires checking and, if necessary, correction of the transmitter frequency and the accuracy of the distance and circling course readings. Replacement of the type MA-250M motor-alternator requires the correction of the 115 v 400 cps voltage.

18. Weight

The total weight of the range finder set without the connecting cables, the type MA-250M motor-alternator and the box with the spare equipment constitutes 22 kg. The weight of the set together with the motor-alternator is 32 kg.

19. Brief Information on the Control and Checking Apparatus

To ensure normal operation, periodical control and repair of the type CA-1M range finders the following control and checking apparatus is produced:

a) a type KMA-5 controlling and testing device;

b) a type ARO-5 avometer.

The type KMA-5 device is a controlling and testing device of the range finder designed for checking and controlling under aerodrome conditions:

a) the general operation of type CA-1M range finders

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b) the operation of the range finder receivers and their decoding circuits;

c) the operation of the range finder measuring circuits and their regulation;

d) the frequency and power of the range finder transmitters;

e) the frequency of the range finder receiver heterodynes;

f) the sensitivity of the range finder receivers;

g) the power supply voltages of the range finders.

Power is measured with an accuracy of ± 10 %; frequency - of ± 0.6 megacycles; sensitivity - of ± 10 %; power supply voltage - of ± 2.5 % for direct current and ± 3 % for alternating current.

The type ABO-5 instrument is an universal avometer designed for measuring direct and alternating currents and voltages and d.c. resistances under laboratory and field conditions.

D.c. and a.c. voltages can be measured from 0 to 6,000 v, currents - from 0 to 12 amp and d.c. resistances from 0 to 30 megohms.

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Chapter II.

DESCRIPTION OF THE TYPE [illegible] AIRCRAFT RANGE FINDER CIRCUITRY

A general schematic diagram of the [illegible] range finder is shown in Fig.19.

1. Range finder transmitter

The range finder transmitter is designed for [illegible] the high frequency interrogation pulses which [illegible] a plane to the ground.

The transmitter consists of (see Fig.[illegible]):

1. A blocking oscillator.
2. A twin pulse oscillator.
3. A modulator.
4. A high frequency oscillator (decimetre waves).
5. A single pulse oscillator.

1. Blocking oscillator

The blocking oscillator is a pulse [illegible] ning the repetition frequency of the [illegible] ses from the plane transmitter. [illegible] niature twin triode and operates [illegible] excitation.

The positive peak of the [illegible] tage following the negative [illegible] the twin pulse oscillator. [illegible] nerated by the blocking [illegible]

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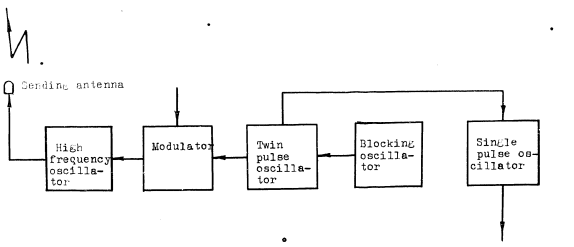

Fig.4. Diagram of type СД-IМ range finder transmitter.

Fig. 4 Page 23a.

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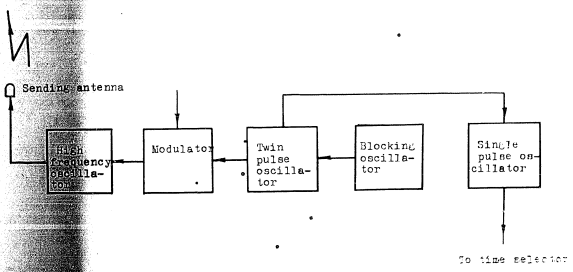

Fig.4. Diagram of type СД-1М range finder transmitter.

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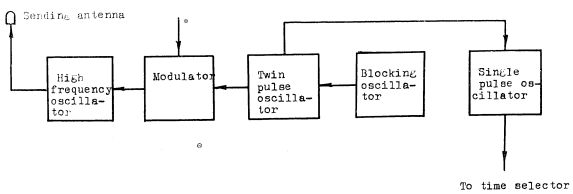

Fig.4. Diagram of type CH-IM range finder transmitter.

Fig. 4 Page 23b.

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...ing pulses are repeated at intervals of about 10,000 micro-seconds).

2. Twin pulse oscillator

From the plate of the blocking oscillator tube the pulse voltage passes to the grid of a type [illegible] thyratron [illegible] which together with another thyratron 2T11, and delay circuit 2P4 forms the twin pulse oscillator. The latter generates a voltage in the form of repeating positive twin pulses with a duration of 1.5 to 1.7 microsec. each, and with an interval between the pulses in a pair of either 2, 4 or 6 microsec. The interval between the twin pulses is equal to that of the blocking oscillator.

The control grid of thyratron [illegible] is biased negatively in such a way that the thyratron is blocked. When the voltage peak of the blocking-oscillator pulse becomes positive the thyratron fires and a voltage pulse appears in the cathode load.

The pulse is formed with the aid of a special former (2P3) included in the plate circuit of the thyratron. Circuit 2P4 is connected to the cathode of thyratron [illegible] and serves as a time delay circuit. The latter has three taps switching by means of two relays - 2P4 and 2P3.

The voltage pulse formed when thyratron 2T10 fires is delayed when passing through the delay circuit and is delivered to the grid of the second type [illegible] thyratron 2T11. The delay of the pulse which is delivered to the grid of the second thyratron is strictly constant if

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the position of the relays [illegible] when the relays are [illegible] over by means of a [illegible] the control panel of the [illegible]

The control grid of the second [illegible] pulse oscillator, the [illegible] ly biased.

The plate circuit of [illegible] thyratron 2Ш10 contains a [illegible]

When the positive pulse [illegible] ses through delay circuit [illegible] of thyratron 2Ш11 the latter [illegible] a duration of 1.2 to [illegible] microsec. [illegible] lag in respect to the first pulse [illegible] load of the thyratrons.

Thus on the cathode load of the [illegible] formed positive twin pulses with a [illegible] 6 microsec. These twin pulses are [illegible] of about 100 cps which [illegible] lators.

[illegible]

The modulating [illegible] uses a type [illegible]

The control grid [illegible] to the cathode load [illegible]

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[illegible] and its secondary winding is connected to the plate of the oscillator tube. The modulator tube is blocked and is activated only when positive pulses are formed in the cathode circuit of the twin pulse oscillator thyratrons. At these moments a large current flows through tube 2A3 which induces a voltage drop on the primary winding of the pulse transformer. As a result a positive voltage pulse of about 2,5 to 2,8 kv is generated on the secondary winding of the pulse transformer. Thus high voltage twin pulses are delivered to the plate oscillator tube.

4. High Frequency Oscillator (Decimetre Waves).

The high frequency oscillator of the range finder transmitter is assembled on a type GU-11E metal-ceramic triode.

The oscillator has two coaxial circuits: one is between the plate and the grid and the other is between the cathode and the grid. The circuit between the plate and the grid is tuned to the required frequency by means of short-circuiting plunger that changes the length of the line.

A pin included in the plate-grid circuit serves for regulating the frequency. This pin terminates in a spline on the front panel of the transmitter.

The cathode-grid circuit is tuned to obtain the maximum power. The operating point of the oscillator tube is selected with the aid of variable resistor 2R8 in the high circuit. During modulation the oscillator generates

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high frequency twin pulses each with a duration of about 1 microsec.

The sensing antenna is powered from the plate-grid circuit. The antenna is connected to the circuit by means of a wire coupling loop, the plane of which can rotate during regulation and thus provides the optimum connection.

5. Single Pulse Oscillator

The single pulse oscillator is designed for producing pulses starting the selector-metering circuit of the range finder receiver. It uses a type TPS - [illegible] thyratron 2[illegible]. A former ([illegible]) is included in the plate circuit of thyratron 2[illegible].

The grid of this thyratron is negatively biased and is coupled to the output of delay-circuit [illegible] of the twin pulse oscillator. Thus the thyratron of the single pulse oscillator will fire and generate a pulse on its cathode load simultaneously with the creation of a pulse by the second thyratron of the twin pulse oscillator.

The duration of the pulse formed on the cathode load of thyratron [illegible] is about 0.6 to 1.4 microsec. The rising time of the pulse is extremely short, which is necessary to ensure accurate operation of the receiver metering circuits.

2. Receiver of the Range Finder

The receiver of the range finder is designed for picking up and amplifying the response signals of a responder

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high frequency twin pulses each with a duration of about 1 microsec.

The ranging antenna is powered from the plate-grid circuit. The antenna is connected to the circuit by means of a wire coupling loop, the plane of which can rotate during regulation and thus provides the optimum connection.

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high frequency twin pulses each with a duration of about 1 microsec.

The sending antenna is powered from the plate-grid circuit. The antenna is connected to the circuit by means of a [illegible] loop, the plane of which can rotate during regulation and thus provides the optimum connection.

[illegible]. Single Pulse Oscillator

The single pulse oscillator is designed for producing pulses starting the selector-metering circuit of the range finder receiver. It uses a type [illegible] thyratron [illegible]. A former [illegible] is included in the plate circuit of thyratron [illegible].

The grid of this thyratron is [illegible] and is coupled to the output of delay-circuit [illegible] of the [illegible] pulse oscillator. Thus the thyratron of the single pulse oscillator will fire and generate a pulse on its [illegible] [illegible] simultaneously with the [illegible] of [illegible] [illegible] of the twin pulse [illegible].

The duration of the pulse [illegible] on the [illegible] of thyratron [illegible] about [illegible] [illegible] time of the pulse is extremely [illegible] [illegible] to ensure accurate operation of the receiver metering [illegible] [illegible].

7. Receiver of the Range Finder

The receiver of the range finder is designed for [illegible] [illegible] and amplifying the response signals of a responder

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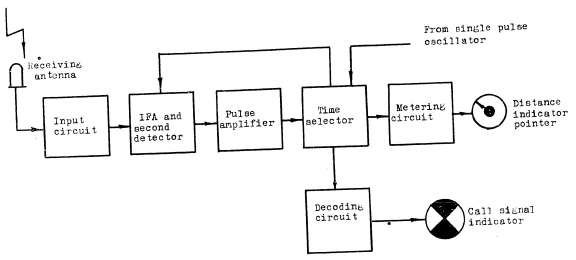

Fig. 5. Diagram of type CD-1M range finder receiver.

Fig. 5 page 11

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beacon. The receiver is a superheterodyne set using miniature tubes.

The receiver (see Fig.5) consists of:

1. An input ultra-high frequency unit comprising a diode mixer and a heterodyne.

2. An intermediate frequency amplifier.

3. A second detector.

4. A pulse amplifier (video-amplifier).

1. Input Ultra-High Frequency Unit

From the receiving antenna the signal passes to the receiver input (diode mixer) via a coaxial feeder. The mixer employs a type 12X3C twin diode 1E1 in a push-pull circuit. The circuit of the mixer is designed in the form of a two-wire line length. The circuit is tuned by changing the length of the two-wire line with the aid of a movable jumper. The cathode of the diode is connected to the load - one of the coils of the first intermediate frequency circuit.

The loop connecting the mixer circuit to the antenna is secured above the circuit and the distance between the latter and the loop can be varied by means of a screw. By changing the distance between the mixer circuit and the loop the optimum coupling is ensured as well as agreement of the receiver input resistance with the feeder of the receiving antenna.

The mixer circuit is tuned to the transmitter frequency of a type PA-1 responder beacon. The high frequency

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voltage of the receiver heterodyne is also fed to the mixer circuit.

The receiver heterodyne uses a type 1C33C ultra-high frequency triode 1L2. The heterodyne resonance circuit is connected between the plate and the grid of the tube. The circuit is designed in the form of a two-wire cut of line length which can be tuned by means of a movable jumper.

The heterodyne and the mixer circuits are connected by a coupling loop.

The rated heterodyne frequency is selected to ensure a 40 mc voltage being generated on the mixer cathode when the responder beacon signal is picked up. The intermediate frequency amplifier is tuned for this frequency range.

2. Intermediate Frequency Amplifier

The intermediate frequency amplifier has six amplification stages using type 6Ж3П tubes 1Л3, 1Л4, 1Л5, 1Л6, 1Л7, 1Л8.

Each stage of the amplifier has its own transformer consisting of two oscillating circuits with an inductance-capacitance coupling. These circuits are formed by inductance coils, the inter-electrode capacitances of the tubes and by wiring capacitances.

The circuits are tuned by means of carbonyl cores. The screen grids of the first 4 tubes of the intermediate frequency amplifier are not under a constant positive voltage.

Therefore the amplifier is usually blocked. The inter-

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mediate frequency amplifier is activated only when [illegible] tive voltage pulse is generated on the time detector [illegible] The last two intermediate frequency amplifier [illegible] their screen grids under a constant voltage.

The bias on the control grids of [illegible] regulated by changing the resistance [illegible] receiver sensitivity is controlled. [illegible] ture varies temperature compensation [illegible] vity) is provided on the last two inter[illegible] plifier tubes 1Л7 and 1Л8 to ensure proper [illegible] range finder.

3. Second Detector

A type 6Д7Л tube 1Л9 connected [illegible] circuit serves as the second detector. [illegible] frequency voltage is fed to the detector [illegible] of transformer 1K7. A negative voltage [illegible] the detector load as a result of the [illegible]

4. Pulse Amplifier

The pulse amplifier of the receiver amplifies [illegible] pulse voltage taken from the second detector load. [illegible] voltage is delivered to one of the grids of type 6Н1П [illegible] 1Л10, is amplified and fed to the second grid of tube [illegible] The second triode of tube 1Л10 is blocked when it is [illegible] rest. A positive pulse will open [illegible] only when its amplitude is [illegible] tude of the noise voltage of the [illegible]

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usually exceed 1.5 v on the second detector load has an amplitude when amplified by the first amplifier stage that is insufficient for activating the second half of the tube 1L10.

Therefore the noise voltage is not amplified by the second half of this tube and it does not reach the grid of the next amplifier stage, while the signal voltage, if it equals or exceeds 1.2 to 1.5 v on the second detector load, will pass through this part of the tube and be amplified by it. Thus an efficient signal voltage is fed to the left hand grid of tube 1L11 that is almost entirely free of the receiver noise. After amplification by the left-hand half of the 6N1P triode the voltage pulses are fed to the grid of the right-hand half of the 6N1P triode of tube 1L11. The right-hand half of the triode is a cathode follower with its load being a resistor included in the cathode circuit of the blocked type 6N1P multivibrator 1L12. These pulses make the multivibrator operate (return it to the initial position).

3. Time Selector of Range Finder

A pointer indicator is used at the range finder output to show the distance. Therefore all the operations connected with distance measurements should be performed automatically.

However besides the responder pulses of the ground responding beacon corresponding to the interrogation pul-

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ses of the transmitter or the particular range finder all the pulses radiated by the beacon in response to many aircraft interrogators are picked up at the receiver input.

Furthermore various noise pulses may be picked up at the receiver input. It is quite evident that for proper operation of the metering circuit with the pointer indicator at its output and which registers the response pulse lag in respect to the moment when the interrogation pulse was sent only those pulses corresponding to the given interrogator should be selected from all the pulses picked up at the receiver input. The range finder time selector solves this problem. As the range finder is to function automatic, the time selector must ensure two kinds of operation:

1. Tracing the response pulses of the responder beacon corresponding to the pulses of the given range finder receiver.

2. "Capturing" and "Accompanying" the response pulses during flight of the plane.

To ensure these functions the pulses of the range finder transmitter generated by the single pulse oscillator and coinciding in time with the second pulse of each pair of interrogation pulses of the transmitter are fed first of all to the selector circuit input.

It is evident that the response pulses of the responder beacon corresponding to the given interrogator pulses will have the same pulse repetition frequency and in addition

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they will have a lag proportional to the distance between the plane and the beacon. All the other pulses picked up at the input of the range finder receiver will not be synchronous with them. If synchronous noise is picked up, this will be only for a very short time.

The operation of the time selector is based on the strict equality of the repetition frequency of the interrogation and the response pulses.

As it has been indicated above, the range finder receiver is blocked and is actuated only for a very short time during each period of the transmitter pulse frequency. The receiver is activated by the time selector simultaneously with the sending of the interrogation pulses, which coincides in phase with the moment of receiving the response pulses.

1. Searching for the Response Pulses

The starting pulses delivered to the [illegible] put from the single pulse oscillator of the [illegible] shown in Fig.6a. A stage of the blocking [illegible] which uses a type 6H1P tube L11 is located on [illegible] lector input. One of the triode parts of [illegible] blocked while the other half of it is [illegible] stable position). The positive [illegible] the transmitter to the grid of the [illegible] tube. The triode which has been blocked [illegible] voltage on its plate will change [illegible]

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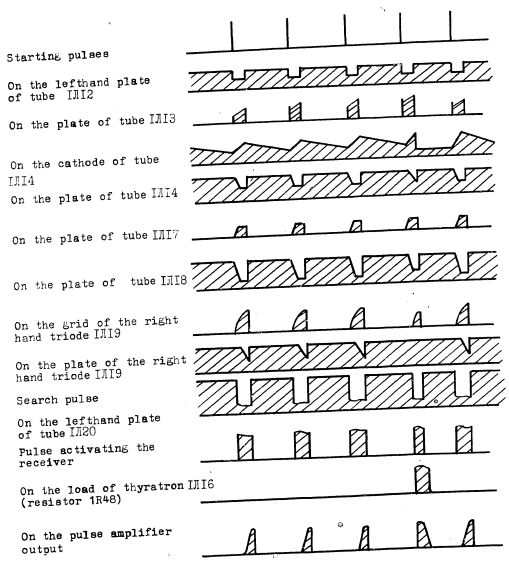

Fig.6. Diagram of voltages in time selector circuit during "searching" duty.

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[illegible] is transmitted to the grid of a type [illegible] tube [illegible] which is opened in its resting condition. The negative voltage which is delivered from tube [illegible] to the grid of tube [illegible] blocks the latter. The capacitors in the [illegible] circuit of this tube begin to get charged (Fig. [illegible]). It is possible to regulate the distance indicator readings on the 2nd scale to obtain the required accuracy by changing the charging rate of the capacitors with the aid of potentiometers 1074 and 1081. The saw-tooth voltage from the [illegible] is applied through a cathode follower (the left half of the type 6H1[illegible] tube [illegible]) to the metering circuit and to the grid of the next time selector stage tube - the charge storing stage. This stage uses a type [illegible] tube [illegible] and is blocked in its resting condition due to the charge voltage on capacitor 1066.

When the saw-tooth voltage on the plate of tube [illegible] begins to increase and exceeds the blocking voltage of the tube a current flows through tube 1[illegible]14 and a front of a negative pulse will be formed in its plate circuit (Fig.6a). The front of the pulse passes further to the grid of amplifier tube 1[illegible]17 (the left half of the [illegible] triode 6H1H). An amplified positive front of the voltage pulse is formed on the plate of this valve and it is supplied to the grids of two type 6H1H and [illegible] tubes [illegible] and [illegible]. The tubes 1[illegible]18 and 1[illegible]19 represent a sort of a "feedback system" ensuring the search for the remainder beacon signals. Tube 1[illegible]18 is blocked in its resting condition. As has been mentioned above, the front of the volt-

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age pulse taken from the left half of tube 1Л17 is fed to the control grid of tube 1Л18 and activates it. The voltage on the plate of this tube drops (Fig.6г).

The voltage drop passes from the plate of tube 1Л18 to the control grid of one of the triodes of tube 1Л19. The anode current flowing through this half of the tube stops and the capacitor connected between the triode plate and the housing begins to charge (Fig.6д). The change in the voltage is fed from the capacitor to the control grid of the second triode of the same tube, which is blocked in its resting condition by a negative bias. Upon completion of the interval the capacitor voltage reaches such a value that the blocked triode of tube 1Л19 becomes activated and a negative front of a voltage pulse (a search pulse) is formed on its plate. (Fig.6е). This negative front of the voltage pulse is delivered to the grid of tube 1Л12 of the pulse amplifier in the receiver circuit of the range finder. As a result a positive front of the voltage pulse appears on the amplifier output and returns the trigger 1Л12 to its initial stable position (Fig.6ж). When this occurs tube 1Л18 opens and the capacitance in its plate circuit quickly discharge, the beginning of this discharge coinciding with the front of the pulse on the amplifier output. The current flowing through the left half of tube 1Л12 and tube 1Л14 stops and therefore the voltage on the plate of tube 1Л14 sharply rises (Fig.6з) and the charging of the capacitor in its cathode circuit begins (Fig.6и). This voltage change is then transmitted to the

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tube 1M14 to the next stages and as a result the decay of the pulses is ensured in all the stages mentioned above.

Thus unstationary process considered above, which is caused by the transmitter starting pulse, stops.

A change in the negative bias on the grid of the right half of twin triode 1M19 causes a change in the opening time of this tube and, consequently, of the search speed. The bias (search speed) is regulated by means of variable resistor 1R114.

The positive voltage pulse from the left plate of tube 1M17 is limited to the minimum, when fed to the first grid of tube 1M20. As the incoming voltage is not of a rectangular form the duration of the voltage pulses on the first plate of amplifier tube 1M20 depends upon the limiting threshold, that is upon the negative bias on the first grid of the tube. The negative voltage pulse formed on the plate of the first triode of tube 1M20 (Fig.6j) passes to the grid of the second triode of the same tube. This voltage pulse is amplified and its maximum limited by the second half of tube 1M20 and then it is fed to the cathode follower (the right half of tube 1M17). The positive voltage pulse of rectangular form is fed from the cathode load of the cathode follower (Fig.6k) to the screen grids of the first four tubes of the intermediate frequency amplifier and thus the range finder receiver is activated. The voltage pulse fed to the screen grids of the intermediate frequency amplifier tubes has a duration of about 25 to 40 microseconds.

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Obviously the range finder receiver is ready to pick up signals during the first peri d of the driving frequency of the interrogation pulses (and consequently of the response pulses) during the 35 to 40 microseconds, which follow immediately after the transmitter antenna of the range finder has radiated the interrogation twin pulses.

The next driving pulse of the transmitter which appears in 10,000 microseconds after the first one, calls forth in the selector circuit the same process as those indicated above. However the capacitor in the cathode circuit of tube 1L14 receives a certain charge, the first pulse activating the receiver is formed.

This charge decreases somewhat by the moment the next starting pulse is delivered, as the capacitor discharges through tube [illegible].

However the rate of this capacitor discharge is so small that the voltage on the capacitor at the moment when the next driving pulse is delivered will be higher than it was at the moment when the previous starting pulse was received (fig.6d).

As a result of the current flowing through tube [illegible] which is caused by the charging of the capacitor in the plate circuit of tube 1L1 will appear in the second period of the starting pulse frequency, not immediately after the driving pulse has been received from the transmitter, but somewhat later. Thus, if the range finder receiver is activated during the first period of the starting frequency of interrogation pulses immediately after the transmitter has

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sent the interrogation twin pulses, then during the second
period the receiver is also ready to pick up the signals
during 25 to 40 microseconds, but with a certain delay in
respect to the moment when the interrogation pulses were
sent. Thus, if the receiver can pick up during the second
period considered a response pulse of a responder station
which is located at a distance corresponding to the time for
the pulse to travel from the plane to the beacon and back
of from 0 to 25-40 microseconds, then during the second pe-
riod the receiver can pick up a pulse from a more distant
beacon.

It is evident, that the active moments of the range
finder receiver will gradually lag behind the moments of
sending the interrogation pulses, i.e. all the distant
ranges will be "investigated". Thus, when searching for
response pulses sent from the land the receiver is able to
pick up a response pulse from any responder station
is within the limits of the distance covered by the range
finder. Lagging behind of the time selector
activates the receiver in respect to the
of the transmitter, resonances from the
lag between the pulses exceeds the
covered by the range finder. The
its initial position as follows:

The voltage on the
tube 1"1 increases more and more
This voltage is delivered to the
thyratron 1"10 through the

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tube 1L22, The thyratron plate is connected to the capacitor in the cathode of storage tube 1L14. The thyratron duty has been selected in such a way that the voltage on its grid ensureswits firing, which causes discharging of the capacitor in the cathode of storage tube 1L14, when the lag between the starting pulse and the pulse that activates the receiver is equal to either 1100-1200 microseconds when the 150 km scale is being used, or 220-230 microseconds when the 30 km scale is being employing (Fig.6d). The moment when the thyratron fires can be regulated by a change in the negative bias on the thyratron grid (the bias is taken from potentiometer 1R97) and in this way the "searching distance" can be controlled.

The voltage which is generated during this process on the cathode resistor of the thyratron is fed to the first grid of pulse amplifier tube 1L11 and as a result multivibrator tube 1L12 becomes blocked.

Charging of the capacitor in the plate circuit of tube 1L13will stop and the capacitor will discharge through tube 1L13.

After this the searching process commences from the beginning.

2. "Capturing" and "Accompanying" a Response Signal

The response pulses of the responder beacon which is interrogated by the particular range finder are strictly synchronous with the range finder interrogation pulses and lag behind the latter in proportion to the distance between

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the beacon and the plane. This lag changes during flight of the plane.

Let us presume that the starting moment of the receiver coincides during a search with the moment when the response pulse has been received. This response pulse will be amplified by the intermediate frequency amplifier and will block multivibrator tube 1J1. As a result of this the charging of the capacitors in the plate circuit of tube 1J1 is stopped before the search pulse from the time selector circuit is fed to the pulse amplifier. Therefore the receiver will be blocked immediately after the response pulse is received. The capacitor in the cathode circuit of storage tube 1J4 will be slightly charged during the active time of the receiver before the response pulse is received but this charge is less than it would be during a search. The capacitor discharges through a type discharging tube 1J5 after the receiver is blocked and the charge of the capacitor changes during a period of the starting frequency approximately by the same value that has been accumulated by the moment of receiver opening.

As a consequence of this the receiver will be activated during the next period of the starting frequency approximately with the same lag in respect to the interrogation pulse of the range finder transmitter as during the previous period. Therefore the receiver will be activated again somewhat earlier than the moment when the next response pulse of the beacon is received. If this next response

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the beacon and the plane. This lag changes during flight of the plane.

Let us presume that the starting moment of the receiver coincides during a search with the moment when the response pulse has been received. This response pulse will be amplified by the intermediate frequency amplifier and will block multivibrator tube 1Л1. As a result of this the charging of the capacitors in the plate circuit of tube 1Л1 is stopped before the search pulse from the time selector circuit is fed to the pulse amplifier. Therefore the receiver will be blocked immediately after the response pulse is received. The capacitor in the cathode circuit of storage tube 1Л4 will be slightly charged during the active time of the receiver before the response pulse is received but this charge is less than it would be during a search. The capacitor discharges through a type crystal discharging tube 1Д15 after the receiver is blocked and the charge of the capacitor changes during a period of the starting frequency approximately by the same value that has been accumulated by the moment of receiver opening.

As a consequence of this the receiver will be activated during the next period of the starting frequency approximately with the same lag in respect to the interrogation pulse of the range finder transmitter as during the previous period. Therefore the receiver will be activated again somewhat earlier than the moment when the next response pulse of the beacon is received. If this next response

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pulse is actually picked up at the receiver input, the receiver will be blocked again immediately after this takes place. As a result a "stationary" process will set in during which the range finder receiver will be set every time with the aid of the time selector slightly before the moment when the beacon response pulse is received. The duration of the rectangular pulse activating the receiver during the "capturing" process is controlled by potentiometer 1R145, which changes the bias of tube 1V18 and consequently, the discharging current of storage capacitor 1C46.

A small change in the lag between the interrogation pulse and the response pulse will take place in the course of every period of the interrogation pulse frequency, this change increasing when the plane is flying away from the responder beacon and decreasing when the plane approaches it.

However the increase in the charge on the capacitor in the storage tube cathode circuit during each period will be either more or less than that which would exist if the plane did not move. Therefore the moment of receiver activation during each period of the starting frequency will either lag behind or approach the moment when the interrogation pulse is sent. Thus "capturing" and "accompanying" of the response pulses will be automatically realized.

The operation of the selector circuit when "accompanying" response pulses is shown in Fig. [illegible]. The [illegible] are given for the same moment of time.

A possibility is provided for [illegible]

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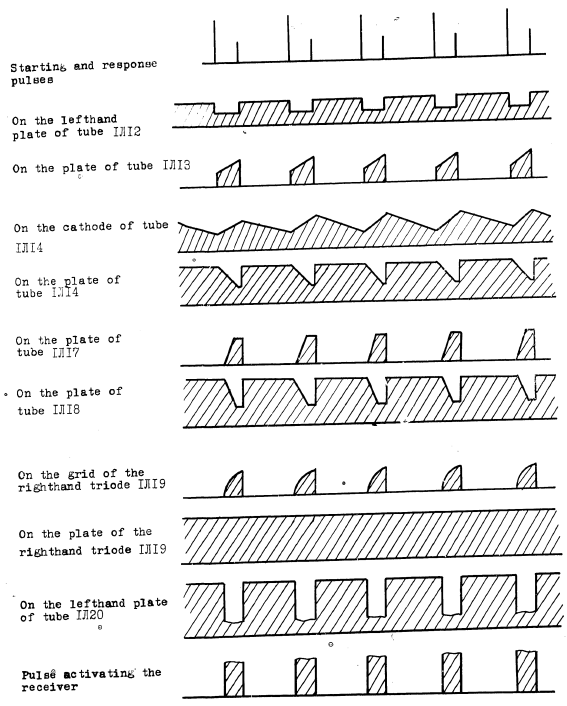

Fig.7. Diagram of voltages in time selector circuit during "capture" duty.

Fig. 7 Page 41a.

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unit of charge increasing by a small value the voltage on the capacitor in the cathode circuit of storage tube 1L2A by pushing the knob "Readjustment" on the control panel of the range finder.

If a response signal of a beacon is "captured" before this moment and the capacitor was charged up to the voltage corresponding to the distance to this particular responder beacon, then even a small but sharp increase in the voltage on the capacitor will cause disrupting of the "synchronism" between the pulses activating the range finder receiver and the beacon response pulses. The response pulses will be "lost" and search duty will begin. If response pulses of another beacon corresponding to the interrogation pulses of the transmitter of the particular range finder are picked up at the receiver input they will be "captured" by the time selector and the distance to this other beacon will be measured.

Thus the possibility is provided of measuring the distance to different responder beacons operating on the same communication channel.

4. Metering and Circling Course Circuits

Metering Circuit

The metering circuit of the range finder serves to generate a current deflecting the pointer of the distance indicator in proportion to the time interval between the interrogation pulses and the response ones, i.e. to the di-

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stance between the plane and the responder beacon.

The metering circuit includes one half of a type 6Н1П tube 1Л22, a type 6Н1П tubes 1Л23 and 1Л24. As has been mentioned above the capacitors in the plate circuit of tube 1Л13 are charged during each period of the pulse frequency to a voltage which is in proportion to the distance, and are again discharged. The voltage on the capacitor placed in the cathode circuit of the right half of tube 1Л22, functioning as a diode, is in proportion to the maximum value of the voltage on the capacitor in the plate circuit of tube 1Л13, the voltage on the capacitor in the cathode circuit of the right half of tube 1Л22 valve changing slightly during a pulse frequency period due to the high discharge rate of the capacitor in this circuit when [illegible] ponse pulses of a beacon.

Thus the voltage on this capacitor will be in proportion to the distance between the plane and the [illegible] beacon. This voltage is fed to the [illegible] 1Л24.

When the distance between the plane and the [illegible] creases, the positive voltage on the grid of tube [illegible] grows and, consequently, the plate [illegible] creases. The distance indicator, which [illegible] current of this tube, is directly [illegible]

Circling Course Circuit

The "Kind of Operation" handle of the [illegible] tor is put in its "Circling Course" [illegible]

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around an aerodrome. Auxiliary tube 1528 is introduced in this instance in the metering circuit and it operates as a d.c. amplifier. The circling course switch, which is located on the control panel, has six positions corresponding to six circling courses, viz. 9, 11, 13, 15, 17 and 19 km. When this switch is set in the required position the corresponding bias is established on the grid of tube 1528, which can be adjusted by means of potentiometer 1R139. The constant voltage from the cathode of the right half of tube [illegible] is delivered to the grid of tube 1528, which amplifies it. Grid voltage for the metering tube is supplied from tube 1528. The pointer of the distance indicator is set at the mark of the circling course scale at the centre of "▽" only when the voltage corresponding to the radius of the circling course selected has been applied to the grid of tube 1528. An increase in the distance between the plane and the beacon will cause deflection of the pointer to the left, while a decrease in this distance moves the needle to the right. If a pilot controls the plane with the indicator pointer remaining at the sign "▽" of the circling course scale, he will be flying around a circle.

5. Decoding Circuit

The beacon response pulses have been coded by exceeding the 7th or the 7th and 8th pulses when transmitting the letters of the Morse code. The decoding circuit of the [illegible] range finder is a blocked multivibrator using a type [illegible] triode 1[illegible]. When a response pulse has dropped out

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the selector circuit of the range finder forms a positive "search" pulse. The "search" pulse is generated on the second plate of tube 1L1 . This pulse, after passing through a differentiating circuit, is delivered to the first grid of tube 1L1 of the blocked multivibrator. The positive pulse obtained as the result of differentiation starts the multivibrator, which generates a positive voltage pulse. The latter is fed to neon lamp MH-7 located on the control panel with the inscription "Call signal" and is connected in series with one of the triodes of tube 1L21. The parameters of the decoding circuit have been selected to ensure the lamp burning continuously until the exclusion of the 7th or the 7th and 8th beacon response pulses is stopped.

6. Calibrating Circuit

For checking the accuracy of graduation of the distance indicator a constant calibrated voltage corresponding to the distances "0" km, 30 - 150 km can be fed to the metering circuit. This calibrated constant voltage is taken from the corresponding point of a voltage divider in the control panel. The value of the voltage is set by means of variable resistor 1R64.

The calibrated constant voltage is delivered to the input of the metering circuit the grid of the left half of tube 1L22) when the buttons "Zero setting", "Circling course setting", "30 - 150 km setting", located on the control panel, are pressed. The potentiometers on the axes of these

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buttons are used to correct the readings at zero, and on the circling course and 30 - 150 km scales. The potentiometer "Zero setting" changes the bias fed from the plate voltage of + 250 v. to the cathode of tube 1Ж24, changing the current of the tube and the readings of the ПРД-50 device. The potentiometer "Circling course setting" is connected in series with the ПРД-50 device in the cathode circuit of tube 1Ж24 and changes the current flowing through the tube. The potentiometer "30 - 150 km setting" shunts the ПРД-50 device, permitting to regulate the current flowing through the device.

7. Power Supply

The range finder is powered by the aircraft [illegible]. An alternating voltage of 115 v, 400 cps, is supplied from a type МА-250М motor-alternator and is controlled by means of the potentiometer, terminating on the front panel of the transmitter with the inscription "115 v setting" [illegible].

Besides this the range finder can be powered directly from a centralized 115 v, 400 cps source on the aircraft mains.

Voltage is supplied to the filaments of the tubes of the range finder tubes through a reducing transformer from the 115 v, 400 cps a.c. power source. Rectifiers are provided in the range finder to create the required plate and bias voltages as well as the biases. The rectifiers are placed in the transmitter unit of the range finder, [illegible] together three rectifiers. A 1000 v rectifier is provided

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to power the modulator tube of the transmitter. It is a half-wave rectifier using a type 2Ц2С kenotron 2Ц1. A full wave rectifier using a type 6Ц5С kenotron 2Ц3 is provided to feed a negative voltage to the grids of thyratrons 2Ц11, 2Ц8 and 2Ц10 to the grids of modulator 2Ц12 and to the tubes of the receiver. A type СГ3С stabilivolt 2Ц6 serves for stabilizing the bias voltage which is fed to the receiver tubes. The third rectifier is a full-wave one using a type 6Ц4М tube 2Ц2. The unstabilized voltage of this rectifier of about 450 v feeds the plates of thyratrons 2Ц11, 2Ц10 and 2Ц8 of the transmitter. The stabilized voltage of 250 v which is obtained from the rectifier with the aid of an electronic stabilization circuit feeds the tube of the transmitter, blocking oscillator, the tubes of the receiver and the time selector. The electronic stabilization circuit of the rectifier consists of two tube stages, a control-amplifying stage and a regulation one. The first stage uses a type 6Ж3П tube 2Ц5 and is designed for controlling and amplifying all voltage changes which take place on the stabilizer input and output. The second stage using a type 6Н3С tube 2Ц7 valve is connected in series with the rectifier load and operates as a variable ballast resistance, the value of which is controlled by tube 2Ц5.

A constant bias for the control grid of this tube is obtained from stabilivolt 2Ц6.

In such a circuit any voltage change on the rectifier input calls forth some additional voltage on the grid of tube 2Ц5. This voltage after amplification acts on tube

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[illegible] and causes a change in its internal resistance, which causes restoration of the initial value of the output voltage. Potentiometer 2R18 is provided for regulating the electronic stabilization circuit (the value of the rectified voltage [illegible]). It is forbidden to feed a voltage to the plate of tube [illegible] of the high frequency oscillator until its cathode is heated. For this end a special time delay device is included in the main power supply circuit. This device [illegible] on the high voltage rectifier in [illegible] min. after the power supply is connected. The device consists of a type [illegible] tube [illegible] and an electromagnetic relay connected in its cathode circuit. [illegible] provided at the expense of the time required for charging the capacitor [illegible] the control grid circuit of tube [illegible].

[illegible] relay in the transmitter switches off the [illegible] power supply [illegible] about [illegible] when the plane [illegible] switches it [illegible] when the plane drops to about [illegible].

There is an automatic guard circuit in the [illegible] which operates and switches off [illegible] of the switched [illegible] transmitter is taken out of its [illegible].

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PART II

INSTRUCTIONS FOR OPERATION OF THE TYPE СД-1М RANGE FINDER

Chapter 1

Unpacking and Inspection of the Range Finder

The СД-1М range finder is delivered in a packing box to an aeroplane plant or to the unit where the [illegible] to be installed on a plane.

Upon receiving the station inspect the box and see that it is not damaged. Unpack the range finder with extreme care. When unpacking check whether there is external damage to the range finder units caused by bad packing and transportation, whether there are dents on the housing or damaged paint, whether the pins in the plug-socket connections have been bent, whether the seals are in place. The total number of seals is 12, including 4 on the receiver unit, 2 on the transmitter unit, 1 on the panel, 1 on the [illegible], 2 on the МА-250М motor-alternator, 1 on the base with spare tubes and tools. The completeness of the range finder outfit is to be checked in accordance with the [illegible] equipment on hand is checked according to [illegible]

The proper functioning of the range finder is to be checked in a shop before the range finder is installed on a plane. For this end the range finder is [illegible] in accordance with an overall diagram [illegible] and its proper functioning checked in accordance with instructions given below.

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Chapter II.

Installation and Assembly of the Range Finder Units on a Plane

The type СД-1М range finder should be mounted on planes in accordance with approved standard dislocation projects which have been checked during control tests.

The principal requirements for locating and assembling the range finder on planes are as follows:

1. The antennas of the range finder must be placed on the bottom surface of the plane so as to ensure their centre lines being vertical in flight.

2. The distance between the receiver and the sending antennas is not important, however the antennas must be at least two meters apart.

3. The antennas should be arranged in such a way that a plane passing through their bottoms will not intersect any large protruding parts of the aircraft: the motor-gondolas, fuselage, gunner's cabin, etc.

Otherwise the antennas may be screened from ground responder beacons and a circle directional diagram in the horizontal plane will not be ensured.

4. There should be no sharply protruding objects (radio pressure receivers, communication antenna uprights, etc.) near a range finder antenna (minimum radius of 1.5 to 1.5 m).

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6. The antennas should be rigidly secured to the aircraft sheathing. A good jumper contact (not over 200 microohms) should be provided at places of connection (the paint must be thoroughly cleaned from the aircraft sheathing under the antenna disk).

7. The sheathing near the antenna must be either whole or well riveted together. There should be no hatches, especially of a big size and with covers which do not provide a perfect contact with the sheathing along the whole perimeter, within a radius of 1 m around the antenna.

7. No water and oil should accumulate inside the aircraft at the places where the antennas are secured. For this end drill 2 or 3 holes in the sheathing near each antenna.

8. The transmitter and receiver units should be located as close as possible to the antennas. The feeders of the sending and the receiving antennas should not be longer than 4 m, nor shorter than 0.75 m.

9. The cable connecting the receiver to the transmitter should not be longer than 6 m.

10. The length of the remaining connecting cables is of practically no importance. To avoid additional losses it is desirable that the type MA-250M motor-alternator MA-[illegible] be placed closer to the switchboard.

11. The distance and the circling course indicator should be secured on the pilot's instrument panel at a place convenient for observation (desirably near the [illegible]-48 instrument).

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12. The control panel is secured at a place convenient for the pilot (or the second pilot) to carry on the required manipulations and also for watching the burning of the indicating lamps.

13. When installing the range finder all the prescriptions pertaining to it in the Air Forces should be followed. All brackets should be thoroughly connected with the body.

All shock absorbing supports should have a reliable contact with the brackets. The armour of the connecting cables should be connected to the aircraft sheathing every 0.3 to 0.5 m. All cables must be secured mechanically and located in places ensuring their maximum intactness. All jumper resistances of the metallization should correspond to the existing requirements.

14. Antenna feeders should also be rigidly secured. No disruption of the external insulating envelope of the feeders should be tolerated.

15. The feeders and cables should be connected to the transmitter and receiver units so that the shock absorbing parts of the devices remain intact, especially at below-zero temperatures, when the feeders and cables become particularly rigid.

16. Freedom of movement of the units having a shock absorbing system should be provided to take up possible vibrations and shocks when landing.

17. A fuse should be placed in the main circuit of the aircraft in a gap of the 27 V bus connecting the

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МА-250М motor-alternator. All the dimensions that are required for location and installation of the range finder equipment on the aircraft are given in the overall dimension - wiring diagram of the range finder (Fig.5).

Chapter III

Preflight Preparation of the Range Finder

Introduction

A 27 v source of power and a КИСД-5 control and measuring device should be at hand for preflight testing of the СД-1М range finder.

The preflight test of the range finder should be conducted directly on the aircraft.

Note: It is forbidden to connect the range finder on an aircraft to the aircraft storage batteries when using the МА-250М motor-alternator with the motors not running, as the range finder consumes 25 amp and the storage batteries will be rapidly discharged.

The КИСД-5 device permits testing the operation of the range finder directly on the aircraft and carrying out the adjustment of the station under operating conditions.

A complete test, replacement of tubes, tuning and repair of the range finder should be performed either under stationary conditions or in a specially equipped shop.

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1. Preliminary Preparations

The following operations should be performed before each flight:

1. Check the intactness of the antennas their reliable securing to the aircraft sheathing and the reliability of their connections to the cables: No shaking of the high frequency couplings is tolerated.

2. Inspect all units of the device and see that they are reliably secured to the aircraft and connected to the cables.

3. Place the handle "Communication channel" on the control panel of the range finder in its "off"position.

4. Connect aerodrome power mains to the aircraft.

5. Check with the aid of the aircraft voltmeter the proper connection of the aerodrome mains (polarity) and the voltage. A wrong polarity may cause failure of the [illegible]-250 motor-alternator.

2. Switching on of the Range Finder

The range finder must be switched on some minutes (5-10) before it is to be used. This time is necessary for heating of the tubes and other elements of the apparatus.

Before switching on the range finder place the handle "range" of the distance indicator at the position corresponding to operation in the range of large distances - 150 km, which is seen from the graduation of the indicator scale.

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The handle "Kind of operation" should be placed in the position corresponding to "Distance measuring"operation. The position of this handle is determined with the inscription at the lower part of the indicator. In this instance the inscription "km" should be seen at the lower part of the scale.

When the above-mentioned operations have been performed the range finder may be switched on. This is done by turning the right hand knob of the control panel bearing the inscription "Switched off 1,2,3".

From the "Switched off" position this knob is moved to the position corresponding to the selected communication channel (channels 1,2, and 3). Switching on of the range finder is controlled by burning of the indicating lamp located in the right hand upper corner of the control panel and bearing the inscription "On" (the indicating lamp should light in several seconds after the knob has been turned).

3. Preliminary Checking of the Range Finder Functioning of the Range Finder

In one to two minutes after switching on of the range finder the pointer of the distance indicator will begin to smoothly move from its resting position (the extreme left-hand position) to the end of the scale.

If there is no reception of pulse signals from the responder beacon the pointer [illegible]

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scale and will smoothly oscillate there. In this instance the lamp "Code" will burn continuously. The presence of this duty, which is characterized by the described motion of the indicator pointer and burning of the "Code" lamp, partly witnesses the good condition of the range finder and the absence of reception of beacon response pulses.

After this the calibration of the distance indicator scale is checked. For this purpose the knob "Zero setting" is pressed toward the control panel. The pointer of the indicator should slowly approach the zero graduation of the scale. If it does not stop exactly at this graduation it should be moved there by smoothly rotating the "Zero setting" knob. Then, by pressing the knob "30-150 km setting" it is necessary to check the graduation of the indicator at another extreme mark of the scale 150 km, after which the zero setting should be again checked and corrected.

Then, having passed over to circling course duty with the aid of the "Kind of operation" handle, by pressing the knob "circling course setting" check and if necessary adjust the "Zero" of the circling course scale (place the pointer at the centre of the mark "▽") by smoothly turning the knob.

The "zero", "30-150 km" and circling course control operations should be carried out carefully and thoroughly.

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It is particularly important to wait for the end of the moment when during these operations the indicator pointer will occupy its extreme position. It should be remembered that the range finder has a rather large time constant and premature stopping of calibration control operations will lead to additional mistakes. Checking of the calibration is also a test of the proper functioning of the apparatus. If checking of the calibration is not successful, as the range finder indicator pointer cannot be set at the "zero" and "30-150 km" marks in the first or the second ranges, this means that the range finder is out of order.

4. Checking the Radiation of the Range-Finder Transmitter

Bring the field indicator, which is a part of the КИПД-5 device, up to the sending antenna and hold it parallel to the latter.

If the transmitter radiates, the neon lamp of the indicator will light.

5. Checking the Functioning of the Receiver and the Metering Part of the Range-Finder

a) Prepare the КИПД-5 device for use (Fig.8). For this end:

1. Place the КИПД-5 device with its antennas at a distance of 5 to 10 m, from the range finder antennas and see that the antennas do not screen each other.

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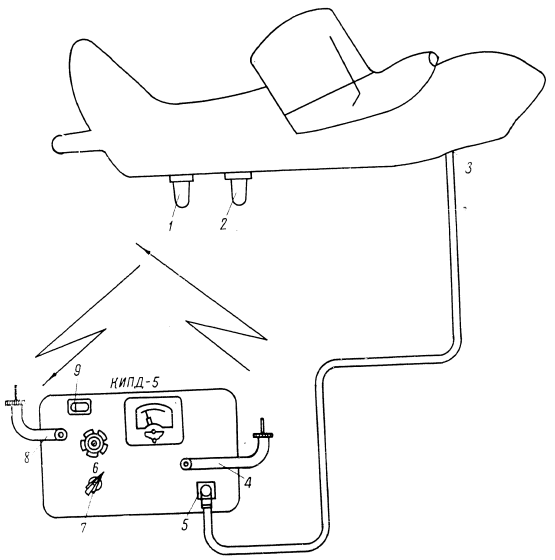

Fig. . Diagram showing how Apparatus is connected for checking receiver operation before a flight.

1 - receiving antenna, 2 - sending antenna, 3 - plug receptacle of aircraft mains, 4 - sending antenna, 5 - power supply, 6 - [illegible] control, 7 - kind of measurment, voltmeter, 8 - receiving antenna, 9 - frequency.

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2. Connect the feed plug of the cable to the jack "Power Supply" on the front panel of the device.

3. Connect the antennas to the high frequency sockets of the KMM-5 device.

4. Connect the feed cable of the KMM-5 device to the aerodrome mains (observe the proper polarity) and switch on the KMM-5 device.

b) Place the handles "Kind of operation" and "Range" on the range finder indicator in the corresponding positions "km" and "30 km".

c) Place the knob "Delay km" on the KMM-5 panel in its "30 km" position.

d) Set communication channel 1 on the panel of the range finder and place the switch "Communication channel" on the KMM-5 panel at position 1. After this the searching duty must stop and the range finder indicator should show a distance of 30 km. The lamp "Call signal" should go out.

e) If a responder beacon is functioning nearby and the range finder captures its pulses, then by pushing the button "Readjustment" or "30-150 km" on the range finder control panel off this beacon.

f) Check the graduation of the range finder scales and the circling course setting. The accuracy of distance indication at the points 0, 9 and 30 km is checked in the first range. When the range finder is transferred to circling course duty and the 9th circling course setting should be checked. After that the knob "Delay km" of the KMM-5 device is set in its "Calling pulse control" position and the handle

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"Kind of operation" and "Range" of the range finder indicator are placed correspondingly in their "km" and "150 km" positions.

By pressing the knob "Readjustment" on the control panel of the range finder the second range is tested at the points 15, 30, 45, 60, 75, 90, 105, 120, 135, and 150 km.

Checking the Communication Channels

a) Place the handle "Communication channel" of the КИПД-5 device successively in its 2nd and 3rd positions. The range finder must not leave the search duty in these positions because the КИПД-5 device gives no response.

b) Repeat the operations indicated in items

c) and d) for the 2nd and 3rd communication channels of the range finder.

Note: If a type РД-1 responder beacon is operating at the aerodrome when the communication channels are being checked then the pointer of the distance indicator will move to the beginning of the scale at any communication channel. There will be no search of response signals.

6. Switching off the Range Finder

The range finder is switched off by turning the handle "Communication channel" on the control panel to its "Off" position. The handles "Kind of operation" and "Range" should be placed correspondingly at their "km" and "150 km" positions.

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Note: The type [illegible] control and measuring device can be used for preflight checking of the СД-IM range finder.

Chapter IV

Operation of the Range Finder by the Aircraft Crew in the Air

1. Use of the Range Finder during a Flight for Measuring Distances

The range finder is ready for work after it has been switched on and its proper functioning has been tested in accordance with the instructions set forth in chapter III paragraphs 2 and 3. Set the 150 km range. If a ground responder beacon is operating the range finder receiver should pick up the beacon response pulses and the pointer of the distance indicator should stop at the scale graduation corresponding to the distance between the aircraft and the beacon. The lamp "Call signal" should go out and light from time to time according to the code of the responder beacon.

As this distance changes during flight of the aircraft the position of the pointer on the distance scale will also change. Thus the indicator of the range finder will show at any moment the actual distance between the aircraft and the aerodrome on which the responder beacon is located. Here the actual distance (inclined distance) is indicated between the aircraft and a circle, at the centre of which the responder beacon is located and which passes through the beginning of the aerodrome landing road. When the aircraft approaches the responder beacon to a distance shorter than the [illegible] distance of the first range (30 km), go over from the long distance scale to the short 0-30 km one.

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This transition is ensured by turning the handle "Range" of the distance indicator. In this case the graduation of the indicator scale changes automatically.

If the range finder and the responder beacon are functioning properly and communication between them is good the indicator pointer should have no noticeable fluctuations when measuring the distance between the aircraft and the beacon. Its readings should be stable. Unstability of the readings, when the indicator pointer moves chaotically along the scale, indicates that the apparatus is not functioning properly. When the distance between the aircraft and the beacon exceeds the measurement range the range finder will transfer to the response signal search duty, which may be seen from the rhythmical vibrations of the distance indicator pointer and continuous burning of the "Code" lamp.

If this happens when operating on the short distance scale the range should be changed. If this happens when the long distance scale is being used and the aircraft is flying away from the beacon the range finder should be switched off.

When measuring a distance within the limits of the range finder operation and if the apparatus is in good order, some "stopping of measurement" is possible, during which the indicator pointer leaves the scale graduation corresponding to the distance being measured, reaches the end of the scale and again occupies its former position, corresponding to the distance between the aircraft and the beacon. This takes place because of a short disruption of communication between the aircraft and the beacon. Such intervals may take place,

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for example, double sharp bursts of the aircraft. They do not disturb measurements and do not indicate improper functioning of the apparatus.

A responder beacon call signal should be noted with the aid of the "Code" lamp to make sure that the beacon used for measuring the distance has been correctly selected. The lamp will flash in accordance with the call signals of the beacon, communication with which is being maintained at that particular moment, and the distance to which is shown by the distance indicator. The call signal is sent by the beacon at equal intervals - approximately twice a minute.

If it is known that other responder beacons are operating in the selected communication channel and the distance to them is within the measuring limits of the range finder it is possible to measure the distance to each of these beacons. There cannot be more than 4 or 5 such beacons operating in the same communication channel and located at a distance of 230 to 240 km from each other, but within the limits of the effective range of the range finder. The transfer from measuring the distance to one beacon to measuring it to another one operating in the same channel is carried out by pressing for a moment the knob "Beacon Switch" on the range finder control panel. When this is done communication of the range finder with one beacon will be stopped and it will pass over to communication with another beacon located at a different distance from the aircraft. In this

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case after pressing the knob "Readjustment" the pointer of the distance indicator will leave its former position and stop at a new point of the scale, corresponding to the distance to the second responder beacon.

This beacon is located by means of its call signals with the aid of the "Code" lamp, as described above.

If it is necessary to measure the distance to other responder beacons operating in the other communication channels the handle "Communication channel" on the control panel should be placed in the position corresponding to the communication channel in which these beacons are operating.

2. Use of the Range Finder when Circling

Circling - a flight along a circle, at the centre of which there is a responder beacon is performed according to the instructions of the aerodrome dispatcher where the plane will land. In this case when the plane approaches the aerodrome the dispatcher should communicate to the pilot the number of the circling course which he should follow while awaiting his turn to land. After these instructions the given circling course is set by means of the handle "Circling courses" on the control panel. Before approaching the circling course the calibration of the circling course diagram is checked. For this end after placing the handle "Type of operation" in its "Circling" position (the inscription at the lower part of the distance indicator will change from "km" to "Circling course") the knob "Circling course setting" is pressed. The pointer of the distance indica-

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should stop at the mark "0" of the circling course scale (at the centre of the scale). If it stops to the right or to the left of this mark, then the calibration of the circling course diagram should be corrected by rotating the handle of this knob to the right or to the left until the pointer occupies the required position. After this it is necessary to return to distance measuring duty in the first range 0 to 30 km, and watch how the plane approaches the distance corresponding to the radius of the given circling course.

When approaching the circling course the handle "Kind of operation" of the distance indicator should be transferred to its position "Circling". In this case the inscription "Circling course" should appear at the lower part of the distance indicator, and the indicator pointer should occupy a position close to the zero of the circling course scale, i.e. approximately at the middle of the scale, if the plane is being flown along the given circle.

When the transition from measurement of the distance to circling flight will be carried out at a distance to the responder beacon exceeding the given circle radius, the indicator pointer will move to the left of the circling course scale zero mark. Therefore the plane should be brought nearer to the aerodrome. If this transition is carried out at a distance smaller than the given circle radius, then the indicator pointer will move to the right of the circling course scale zero mark. In this case the plane should be flown away from the aerodrome. The plane will keep to the

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circling course when the pointer of the distance indicator will continuously be near the zero mark of the circling course scale. It should be borne in mind that when using the range finder as a "zero-indicator" during a circling flight its "distance sensitivity" sharply increases. In this case the deflection of the pointer from the zero mark of the circling course scale to the extreme left hand or extreme right hand position will correspond to an inclination from the given circle of 100m to 150 metres. An accurate circling flight, when the indicator pointer does not deflect from the zero mark of the circling course scale, demands adequate training.

Besides this during a circling flight it is necessary to see that the "Call" signal" lamp does not light. If there are response signals and the range finder is functioning properly this lamp should light only when call signals are received. Continuous burning (when no response signals are received) indicates that communication between the plane and the responder beacon is disrupted. If this occurs the pointer of the circling course indicator will be either in its extreme right hand or left hand position or will fluctuate at the centre of the scale. In this instance return to distance measuring duty in the first range and return again to circling course duty only after reception of the response signals.

The moment when the plane is to leave the circling course for landing or is to transfer from one circle to another is indicated by the aerodrome dispatcher. When going over from one circle to another one only the handle "circling courses" on the control panel should be switched over.

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3. Use of the Range Finder for Determining the Distance from the Aircraft to the Landing Point when Landing

As the range finder indicates the distance from a plane to the circle which passes through the beginning of the aerodrome landing road, then, when coming in for landing the readings of the range finder distance indicator correspond to the distance from the plane to the beginning of the landing road. When transferring from circling flight to a landing course flight the handle "kind of operation" of the distance indicator should be placed in its "Distance" position and the handle "Range" should be placed in the position corresponding to short distances.

If the plane is going into land, then before doing this it is necessary to check and, if required, to adjust the "zero" of the distance scale, for increasing the accuracy of measuring the distance to the landing point. For this end the pilot should press the knob "zero setting" on the control panel (the pointer of the distance indicator will move to the left) and wait until the pointer stops moving. If the pointer does not stop exactly at "0" of the scale, then without releasing the knob the latter should be slowly turned until the pointer coincides with the "0" of the scale. Upon completing this adjustment the plane may be flown for landing. At the moment of landing [illegible] has landed exactly at the beginning of the landing road.

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the pointer of the distance indicator should be opposite the zero mark of the scale.

If for any reason landing is not accomplished, then when the plane has flown over the beginning of the landing road the pointer of the distance indicator passes slightly beyond the zero mark of the scale, which indicates that the plane is within the circle which passes through the beginning of the landing road. Then the pointer will again approach the zero mark of the scale (the plane passed out of the circle indicated above). The distance indicated by the range finder will then increase as the plane continues its flight.

4. Using the Range-Finder for Calculating the Speed of Approaching an Aerodrome and the Time Remaining for Approaching It

To determine the speed of a plane approaching an aerodrome the time should be registered and the inclined distance should be measured with the aid of the range-finder. Both these values must be recorded again in a certain time. The speed of the plane approaching the aerodrome (or the speed of a plane flying away from the aerodrome) is determined by simple division of the distance covered by the time elapsed between the first and the second measurements.

To determine the time left for approaching an aerodrome the distance to the drome indicated by the range finder should be divided by the speed of the plane.

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Chapter V.

After-Flight Inspection

1. Check the reliable securing of the antennas.

2. Inspect the cables at the places where they can be worn out because of contact with parts of the aircraft.

3. Make sure of the reliable connection of the cable couplings.

4. Check the reliable securing of units and cables.

5. Check all those parameters of the range finder which were not normal during the flight (in accordance with the pilot's remarks).

6. Check the proper functioning of the range finder as indicated in chapter III, paragraphs 2,3 and 5.

7. Switch off the range finder and set the handle "Kind of operation" in its "km" position, and the handle "Range" in "150 km" position.

8. Check the presence of fuses in the spare equipment of the range finder.

Chapter VI

Maintenance of the Range Finder

1. Maintenance during Operation

During operation of the range finder it is important to adhere to the following prescriptions:

1. Do not permit sharp blows against the range finder apparatus during assembly transportation etc.

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2. Do not permit operation of the range finder when the supply voltage differs from the rated value (27 v) by more than +2.7@ -2.0 v.

3. See that the cable couplings are reliably connected not toleratihg intermittent contacts and contamination of plug and receptacle surfaces.

4. Do not disconnect the hight frequency feeders and cables with the supply voltage switched on.

5. Do not switch on the voltage only to separate range finder units (for example without the distance indicator).

6. Control the "0", "10-150 km" and "Circling course" setting with extreme care. It is especially important to wait until the indicator pointer during this checking reaches its final position. It should be kept in mind that the device has a quite large time constant, and premature stopping of calibration checking will cause additional errors.

7. The live range finder should not be left on search duty for a long time, especially at circling course duty. But if necessary, distance measurement duty in the 2nd range should be employed.

8. Replace fuses that have burnt out only with ones of the same type and ratings of factory production.

9. Do not leave range finder connected if its readings are not necessary, when climbing to high altitudes, flying away from a beacon at a distance exceeding the working range of the range finder, and when the plane is running along an aerodrome.

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1. Watch the intactness of the range finder antennas and do not permit their contamination. See that no water and oil accumulate at the places inside the aircraft where the antennas are secured to the sheathing.

2. Maintenance in Storage

Type SF-1M range finder should be stored in strict conformity with duty instructions.

2. It is forbidden to pack the range finders in boxes made of a moist material and with wet shavings. The apparatus should not be packed without thorough wrapping in waterproof paper.

3. Transportation of the apparatus without special packing is prohibited.

4. Do not permit sharp blows against the range finder units, even if they are properly packed.

5. It is forbidden to store range finders together with materials that call forth metal oxidation (for example it is forbidden to store range finder together with storage and dry cell batteries).

6. After storage and unpacking the equipment of the range finder should be checked according to the certificate and the proper functioning of the range finder should be tested, before installing the equipment on a plane.

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Chapter VII

Preventive Checking of the Range Finder

1. Work to be Performed after 25 Hours

(This work is to be carried out after 25 hours of range finder operation but at least once in 3 months).

The range finder is checked directly on the aircraft without opening up the units. The following parameters of the range finder should be checked:

1. The frequency of the transmitter oscillator in accordance with chapter VIII, paragraph 5.

2. The frequency of the receiver heterodyne in accordance with chapter VIII, paragraph 4.

3. The proper functioning of the range finder as indicated for after-flight preparation in accordance with chapter V and chapter VI, paragraph 4.

Note: If the range finder does not operate properly and the fault cannot be eliminated directly on the plane, then the range finder is removed from the plane and sent to a shop.

2. Work to be Performed after 50 Hours

(This work is to be carried out after 50 hours of range finder operation, but at least once in 6 months).

1. Remove from the aircraft the transmitter unit of the СД-IM range finder.

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2. Open this unit in stationary conditions, in a shop.

3. Thoroughly check the 2Д -7 motor:

a) the reliable contacts at all places of connection to current-carrying conductors;

b) the proper installation of the brushes into the recesses of the brushholders and the position of the springs pressing the brushes against the commutator;

c) the state of the brushes. The brushes must fit closely, with their whole surface, against the surface of the commutator;

d) the state of the commutator;

e) Remove the brush dust.

4. Check the reliable securing of units and large parts.

5. Blow away the dust.

6. Inspect thoroughly the unit assembly and eliminate all faults traced during the inspection.

It is strictly forbidden to change the assembly and the arrangement of the wires.

7. Put the housing onto the unit and install it on the aircraft.

8. Check and if required regulate in accordance with the methods given in chapter VIII the oscillator frequency of the transmitter, the power of the high frequency oscillator, the heterodyne frequency, the sensitivity of the receiver, the search velocity and the calibration of the range finder scales.

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Note: If fault traced cannot be eliminated directly on the aircraft, then the range finder is removed from the aircraft and sent to a shop.

3. Work to be Performed after 100 Hours

(This work is to be carried out after 100 hours of range finder operation, but at least once a year).

The range finder is checked in a special shop.

1. Remove all the range finder units from the aircraft.

2. In stationary conditions, in a shop, open the station units.

3. Check the range finder as indicated in chapter VII, paragraph 2, items 3, 4, 5, 6 and 8.

4. Check and if necessary adjust the stabilized voltage of 250 v and the search range in the 2nd range in accordance with the methods given in chapter VIII, paragraphs 2 and 8.

5. Put the housings on the units and secure them with screws.

6. Remove the antennas from the aircraft sheathing and clean the place of contact between the antenna flange and the aircraft sheathing.

7. Install the range finder on the aircraft and check it in accordance with the items of chapter III and chapter VII, paragraph 1, item 1.

If the work indicated above is performed, and if the equipment is regulated after replacement of the tubes the manufacturer's guarantee period remains upon the corresponding records of this work being made in the certificate.

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If the guarantee period is prolonged and, if necessary, during repairs check all the parameters of the range finder in accordance with chapter VII, paragraph 3 (Work to be performed after 100-hours), as well as the parameters of the pair pulse oscillator, the single pulse oscillator, the modulator, the natural blocking-oscillator frequency, the input circuit frequency of the receiver, the receiver bandwidth, the search range, the coupling of the input circuit with the antenna, the duration of the pulse activating the receiver in accordance with the methods given in chapter X.

Furthermore if the guarantee period is prolonged the duty of all tubes should be checked for conformance to their voltage diagrams.

If the duty of any tube is not proper, the resistors in the tube circuit should be checked. The resistors not corresponding to standards (with the tolerance taken into account) should be replaced.

Note: 1. КИПД-5 device is to be used during regular maintenance work. During repairs and when prolonging the guarantee period КИПД-1, КИПД-2, and КИПД-4 devices are also employed.

The methods of tuning the range finder with the aid of these devices are given in chapters IX and X.

Chapter VIII

Methods of Checking Range Finder during Regular Maintenance Work

A КИПД-5 device is used during regular maintenance work.

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1. Switching on of the КИПД-5 Device.

Connect the power cable of the device to a plug receptacle of the mains (26 to 30 v). Switch on the device. Press down the handle "Aircraft mains, heating" to it "Heating" position and by turning the knob "Heating control" place the pointer of the device opposite the red mark on the lower voltmeter scale (25 v).

2. Checking the Voltage Supplied to the Range Finder.

A jumper box is connected between the "Transmitter" jack of the range finder and the cable leading to it. The handle "Kind of measurements, voltmeter" is placed in the position "Control, 300 v, 30 v". The sockets "27 v" and "3" of the jumper box are connected with conductors correspondingly to the terminals "+30 v" and "3" on the front panel of the КИПД-5 device. The voltage supplied to the range finder is read on the lower scale of the КИПД-5 voltmeter. The conductor is transferred from the "+30 v" terminal to the "+300 v" terminal on the front panel of the КИПД-5 device. The other end of this conductor is transferred from the "+27 v" socket of the jumper box to the "+250 v" socket. The 250 v stabilized voltage of the range finder is measured. The reading should be taken on the upper scale of the device. After this both conductors are taken out of the jumper box sockets and the terminals on the front panel of the КИПД-5 device. The handle "Kind of measurement, voltmeter" is placed in the position "СД-IM control, -150 v". Conductors are inserted into the terminals "150 v, 400 cps" on the front panel of

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the КИЛД-5 device and the other ends of these conductors are placed in the "150 v, 400 cps" sockets of the jumper box. The reading of 115 v, 400 cps voltage should be taken from the central scale of the voltmeter. After measuring the voltages the jumper box is disconnected.

3. Checking the Radiation of the Range Finder Sending Antenna

The radiation of the range finder sending antenna is tested with the aid of a field indicator after the time relay of the range finder operates. The field indicator is brought up to a distance of 3 to 5 cm from the sending antenna of the range finder. The neon lamp of the indicator should burn steadily.

4. Checking the Heterodyne Frequency of the Range Finder Receiver

The КИЛД-5 device is placed near the receiving antenna of the range finder. A high frequency cable 3 m long is connected to the high frequency jack "Receiving antenna" on the front panel of the КИЛД-5 device. A coupling antenna is connected to the other end of the cable. The coupling antenna is secured on the receiving antenna of the range finder. The handle "Kind of measurement, voltmeter" is placed in the position "Freq. high sensitive". The maximum deflection of the voltmeter-indicator pointer should be achieved by rotating the knob "Frequency, mc". It is best of all to measure the heterodyne frequency when the high voltage of the transmitter is switched off (unsolder the fuse 1 amp 115 v, and [illegible]

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5. Checking the Transmitter Frequency of the Range Finder

The handle "Kind of measurement, voltmeter" is placed in the position "Freq. low sensitive". During operation of the transmitter the maximum deflection of the voltmeter is regulated by means of the knob "Sensitivity".

6. Estimation of the Range Finder Transmitter Power

The high frequency output of the range finder transmitter is connected through an attenuator to the КИПД-5 device output in accordance with Fig.9. The attenuator is placed in a position corresponding to 30 decibel weakening and is secured with a locking screw. The handle "Kind of measurement",voltmeter" is placed in the position "Freq. high sensitive" and the input circuit of the КИПД-5 device is tuned to the transmitter frequency by means of the knob "Frequency, mc". After this the handle "Kind of measurement, voltmeter" is placed in the position "Power, 300 v" and the knob "Delay, km" is placed in the position "Calibr.impulse control". The knob "Power, w." on the front panel of the КИПД-5 device is placed in its extreme left hand position and is then slowly rotated couhterclockwise. When rotating the knob "Power, w" the neon indicating lamp should go out. According to the position of the knob "Power, w", which has an indicator, the pulse power of the transmitter can be estimated when the neon lamp goes out.

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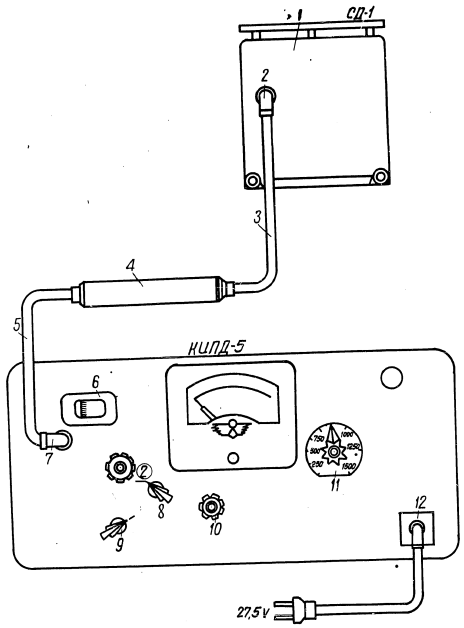

Fig.9. Diagram showing how the apparatus is connected for measuring power.
1 - transmitter of the СД-1М range-finder, 2 - sending antenna,
3 - high frequency cable, 4 - attenuator, 5 - high frequency cable,
6 - frequency, mc, 7 - receiving antenna, 8 - communication channel,
9 - kind of measurement, voltmeter, 10 - sensitivity, 11 - power, W,
12 - power supply

Fig.9 Page 77a

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Note: The highest accuracy of measurements is obtained for operation on the second channel.

7. Estimation of the Range Finder Receiver Sensitivity

The input of the range finder receiver is connected to the КИПД-5 transmitter output in accordance with Fig.10. The internal part of the attenuator is connected to the КИПД-5 output through a high frequency cable, and the external part with the input of the range finder receiver. The attenuator is placed in the position for maximum coupling (the attenuator is fully introduced). The knob "Frequency, mc" is placed in the position corresponding to the transmitter frequency of the range finder, and the handle "Kind of measurement, voltmeter" - in the position "СД -IM control, 150 v". The knob "Delay, km" of the КИПД-5 device should be placed in the position 50 km" and the handle "Range" of the СД-IM range indicator - at the 1st range. The КИПД-5 response signals should be "captured" by the receiver of the range finder. While smoothly extending the attenuator watch either the neon lamp "Call signal" on the control panel of the range finder or the pointer of the distance indicator. At the moment when the neon lamp light or the pointer of the distance indicator moves away from its initial position which shows that the range finder has gone over to response signal search duty, a reading of the scale ending of the КИПД-5 transmitter signal is taken from the

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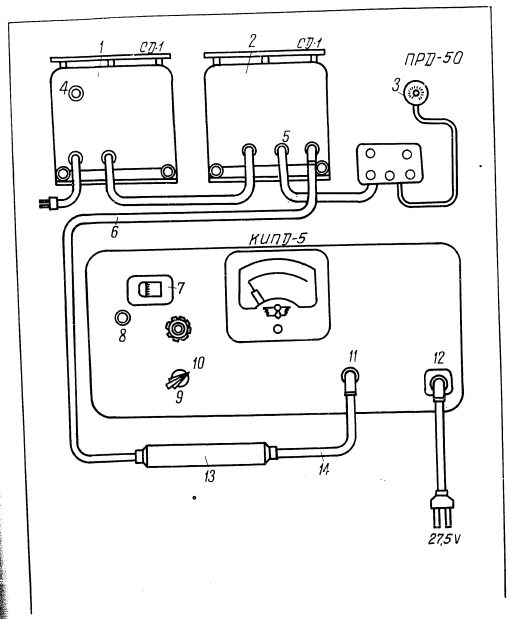

Fig.IO. Diagram showing how the Apparatus is connected for measuring sensitivity. 1 - transmitter of the СД-IМ range finder, 2 - receiver of the СД-IМ range finder, 3 - ПРД-50 device, 4 - sending antenna, 5 - receiving antenna, 6 - high frequency cable №2, 7 - frequency, mc, 8 - receiving antenna, 9 - kind of measurement, voltmeter, 10 - СД-I control, ~150v, 11 - sending antenna, 12 - power supply, 13 - antennuator, 14 - high frequency cable №1.

Fig. IO Page 78a.

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attenuator scale. The sensitivity of the range finder receiver is estimated according to the value of this weakening (according to the diagram on the КИПД-5 cover).

8. Checking the Distance Scales of the Range Finder

Screw rod antennas onto the high frequency couplings of the КИПД-5 device. Before checking the distance scales the distance indicator of the range finder is thoroughly calibrated at the graduations " 0 km", "30 km", "150 km" and "0" of the circling course scale. At first, when using the first range, the accuracy of the distance indication is checked for the graduations 0, 9 and 30 km. Then, using the second range, the accuracy of the distance indication is checked for the graduation 30 km. The 9th circle is checked for circling course duty. The knob "Delay, km" is placed in the position "Calibr. pulse control" and the 15th circle is tested. Then the second range scale is tested at the graduations 15, 30, 47, 60, 75, 90, 105, 120, 135 and 150km. For this end when the range finder is operating in the second range, the pointer of the distance indicator is made to reach the 15 km graduation by pressing several times on the knob "Readjustment" on the control panel of the range finder. After this each pressing and releasing of the knob "Readjustment" will move the distance indicator pointer 15 km. After checking the "150 km" graduation on the search range can be checked. For this end by the next pressure on the knob "Readjustment" the range finder receiver is set for "capturing" response signals that are delayed for

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the time corresponding to a distance of 165 km. This signal should be "captured". After the next pressure on the knob "Readjustment" the distance indicator pointer should move either to the "0" or the "15 km" graduation.

9. Checking Range Finder Operation in the Communication Channels

Stable "capturing" of the response signals should be ensured if the same communication channels are set on both devices (КИПД-5 and СД -1М).

Note: In doubtful cases, when the communication channels are mixed, repeat the checking with a greater distance between the КИПД-5 device and the range finder antennas before deciding that the range finder is defective.

Chapter IX

Instructions on Tube Replacement

1. Tubes 6Н1П, 6Ж3Н, and ТГ 3-0.1/1.3

To extract a tube press down the metal cap from above and turn it to the left as far as it will go, and then stop the pressure and remove the cap. The tube is extracted vertically upward. A very slight snaking of the tube is permitted. Holding the new tube by its bulb and having found the wide gap between the tube pins and between the holes of the tube panel, insert the tube from above vertically without any pressure. Having made sure that the pins are in the proper holes, insert the tube by pressing it down. Never

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the tube with the metal cap, seeing that the protrusions on the base and on the cap coincide. Then press down the cap from above and turning it to the right as far as it will go, release the cap. Make sure that the cap is secured by pulling it upward.

2. Tubes 6P3C, 6Ц5C, 2Ц2C, TG-0.1/1.3, 5Ц4M

These tubes are extracted with the aid of a special wrench.

Pressing with the wrench from above on the spring holders and holding the tube bulb with the right hand extract the tube upward, while slightly shaking it. When replacing the tube with a new one find the guiding projection on the base pin and the groove in the tube panel. Insert the tube vertically, pressing it down until the spring holders are engaged with the base edge. The wrench is not necessary here.

3. Tubes TG-30

Remove the plate terminals by pulling them up. Compress the spring ring surrounding the tube and remove it.

Holding the tube bulb with the hand and carefully shaking it, regripping the tube when necessary, extract it upward. When installing a new tube insert it from above vertically, making the large pin of the tube coincide with the large hole in the ceramic panel. After making the pins enter the corresponding holes, insert the tube vertically as far

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as it will go without shaking it. Put on the spring ring [illegible] the plate terminals on the tube pins without knocking against the tube glass.

4. Tubes of the Type TM-11 High Frequency Oscillator

By unscrewing a nut from the high frequency jack of the oscillator take off the board with the inscription "Sending antenna" from the front panel and then remove the terminal connecting the oscillator to the pulse transformer. Unscrew the three permanently attached screws with the aid of which the upper part of the oscillator is fastened to the lower one.

Holding the upper part of the oscillator with the right hand and forcing the left hand against the edge of the front panel, pull the upper part of the oscillator upward until the tube comes out the helical spring of the cathode-grid circuit. Then turn the upper part of the oscillator counterclockwise until the terminal block is drawn out of the panel hole, and extract it upward. Unscrew the coupling nut securing the tube by turning the tube clockwise; extract it from the circuit together with the central tube of this circuit, which is called a plate terminal. Unscrew the plate terminal from the tube.

When installing a new tube put a flexible [illegible] on the plate and screw the plate terminal into the tube plate, seeing that the screw has gone into the hole, as deep as possible.

Connect with care, as an excessive pressure may damage the tube or the capacitor ceramic in the plate terminal.

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first the plate terminal, and then the tube in their places in the plate-grid circuit by turning in the same direction as during dismantling (clockwise). Screw on the coupling nut.

Note: If the new tube has a radiator, then it must be removed with the aid of a corresponding socket wrench. When unscrewing the radiator nut by means of this wrench, first hold the radiator, and then the tube when the nut is going freely. It is forbidden to touch the tube ceramic and the plate terminals. Take hold only of metal parts. Wash with acetone or alcohol in case of dirt.

Having loosened the three screws which secure the leading ring of the cathode line, lift its plunger upward toward the chassis and secure all the screws again. Insert the upper part of the oscillator into the lower one and turn it clockwise until the terminal block will bear against the edge of the hole in the panel. Having made sure that the cathode cylinder of the tube has entered the plunger springs and that the heater terminal is in its hole, press down from above as far as it will go and screw in the three permanently attached screws. Put the terminal of the pulse transformer onto the oscillator pin. After this tune the oscillator and reliably secure its plungers, tighten the lock-nut and the screws and replace the board with the inscription "Sending antenna". Screw the nut onto the high frequency jack of the oscillator.

4. Tubes 12C3C and 12X3C

The type 12C3C and 12X3C tubes have special holders on top for facilitating their replacement. These holders are freely screwed out and screwed in again in the tube caps.

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[illegible] hold of the holder, extract the tube by carefully lifting it.

When installing a tube, by turning the tube around its axis make the key on its cap coincide with a groove in the holder, and after that move the tube downward as far as it will go.

6. Lamps MH-7

For replacing the indicating neon lamp MH-7 unscrew the cap covering the lamp, holding the knurled ring at the bottom of the cap. After this by turning the lamp counterclockwise and slightly pressing it down it is released from the holder and lifted upward.

A new lamp is inserted by turning it clockwise and slightly pressing it downward. After the lamp has been replaced the cap is screwed on with its unpainted part facing upward on the board of the control panel.

7. Instructions for Regulation after Replacement of tubes.

After replacing oscillator tube [illegible] check and regulate the oscillator frequency and power in accordance with chapter 4, paragraph 4.

After replacing heterodyne tube 1Л2 check and regulate heterodyne frequency in accordance with chapter X, paragraph [illegible].

After replacing metering circuit tubes 1Л 13, 1Л 22, 1Л 23 and 1Л 24 check and if necessary regulate the circling course and the 1st and 2nd range scale setting in accordance with chapter X, paragraph 6.

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After replacing intermediate frequency amplifier tubes 1Ж 3, 1Ж4, 1Ж 6, 1Ж 7, 1Ж 8, and 1Ж 9 the amplifier gain should be checked and if necessary regulated in accordance with chapter X, paragraph 3.

After replacing tubes 1Ж 14 and 1Ж 15 the length of the pulse activating the receiver should be checked and regulated. After tube 1Ж 16 has been replaced check and regulate the search range in accordance with chapter X, paragraph 6.

After replacing tubes 2Ж 5, 2Ж 6, and 2Ж 7 of the electronic stabilization system the 250 v voltage should be checked and regulated in accordance with chapter X, paragraph 3.

After replacing blocking-oscillator tube 2Ж 9 the natural frequency of the blocking - oscillator should be checked and regulated in accordance with chapter X, paragraph 4.

After replacing search tube 1Ж 19 the search time should be checked and if necessary regulated in accordance with chapter X, paragraph 6.

Replacement of other tubes of the range finder requires checking. It is necessary only to test the general operation of the range finder using the КИПА-1 or КИПА-3 devices.

Chapter X.

Methods of Tuning the Range Finder

1. Shop Equipment

To ensure rapid and thorough checking and tuning of the range finder the following apparatus and sources of power supply should be provided in the shop:

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1. A type СД-IM range finder set in good repair (corresponding to the technical requirements).

   By replacing the set that is in good order with the one to be tuned it will be possible to rapidly trace and eliminate all causes of faults.

2. A source of power for 27 v, 1000 w.
3. A set of control and measuring apparatus: КИПД-1, КИПД-3, КИПД-4, АВО-5 and КИПД-5.
4. A type СГ-1 signal-oscillator.
5. A type 27-М quartz calibrator.
6. A type 25-М oscillograph
7. A type ЗГ-1 audio oscillator.
8. A d.c. 50 amp.ammeter.

When checking regulating and repairing the range finder the electrocalibration diagrams (Fig.11 and 12) and the schematic diagram of the range finder given in an appendix to this instruction should be used.

2. Checking and Regulating the МА-250М Motor-alternator

Check the voltage created by the МА-250М motor-alternator in accordance with the operating instructions for the КИПД-5 device.

2. Check the operation of the carbon regulator, stabilizing the output voltage of the МА-250М. For this end by changing the supply voltage from 25 v to 29.7 v see whether the voltmeter reading remains within the limits indicated in the technical requirements for the СД-IM range finder. If the out-

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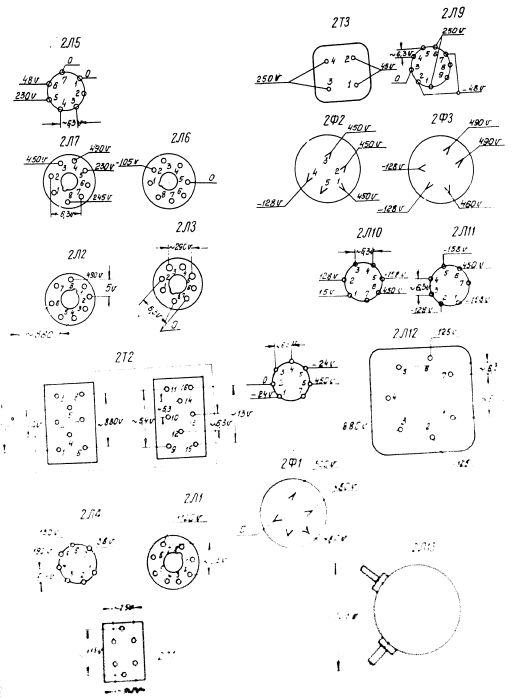

Fig.11 Page 86a.

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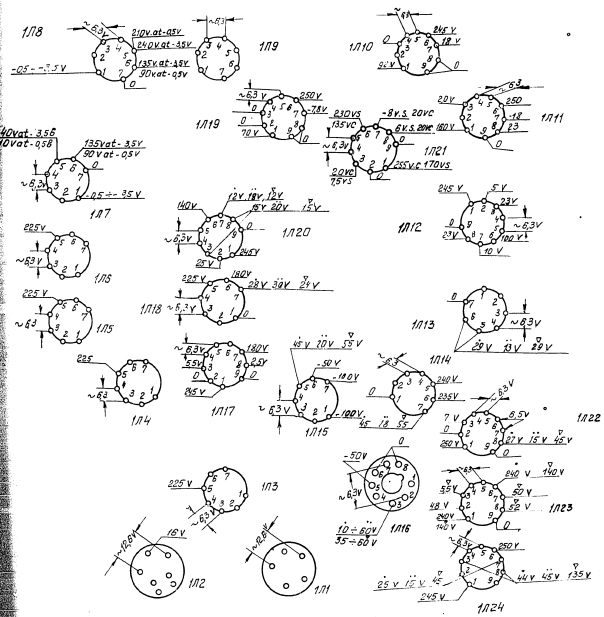

Fig.12. Voltage diagram for the receiver unit.

The constant voltages have been tested in respect to the ground with an AVO-5 device, on the 300v.scale during operation with an accuracy of ±20%. . on the first range 15km. ..on the second range15km. Δ on the 15t. circle. The absence of a sign (. .. Δ)indicates that the voltage does not depend on the handle position. C- "capture", S-"search".

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put voltage of the MA-250M is beyond the limits given in the technical requirements, the MA-250M motor-alternator should be replaced.

3. Checking and Regulating the Transmitter Power Supply Unit

1. Remove the housing from the transmitter and close the contacts of the automatic interlocking system, which are located at the rear of the chassis, by means of a closer. (the closer of the automatic interlocking system is included in the set of spare parts of the range finder).

2. Switch on the range finder power supply, feeding 27 v to the MA-250M.

Warning. When working with the transmitter extracted from its housing be extremely careful, as the high voltage rectifier gives a voltage of 1000 volts.

3. Measure the high voltage supplied to the range finder (about 250 v) in accordance with the operating instructions of the КИПД-5 device. If the voltmeter of the КИПД-5 device indicates a voltage higher or lower than 250 v, then by turning the spline of potentiometer 2R16 in the transmitter unit bring the voltmeter pointer to 250 v.

4. Check how the voltage is stabilized at the output of the stabilizing rectifier. For this and while changing the supply voltage from 22 v to 29.7 v register the position of the КИПД-5 voltmeter pointer. The latter should not go out of the limits indicated in the technical requirements for the СД-1М range finder.

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4. Check the voltage at the following points: the 6th pin of tube 2Ж1, the 8th pin of tube 2Ж2, the 2nd pin of tube 2Ж3, the 2nd terminal of transformer 2Т3. The voltages at the points listed above should correspond to the electrocalibration diagram in Fig.11.

After this the regulation of the power supply unit is considered to be completed.

4. Checking and Regulation of the Transmitter Unit

Checking the Natural Blocking-Oscillator Frequency

1. The natural blocking-oscillator frequency is checked with the aid of an audio-oscillator and an oscillograph.

2. Feed a voltage from the audio-oscillator to the X-plates of the oscillograph.

3. Connect the Y-plates of the oscillograph with the receptacle of the 2ШР3 coupling.

4. Switch on the oscillograph, the range finder and the audio-oscillator.

5. By changing the frequency of the audio-oscillator obtain one fixed pulse on the screen of the oscillograph.

6. Reduce the frequency of the audio-oscillator two times. When this has been done two pulses should appear on the oscillograph screen. The frequency of the blocking-oscillator will correspond to that frequency of the audio-oscillator, for which one pulse is obtained on the oscillograph screen. The frequency of the blocking oscillator should be within the limits of 100±8 cps.

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Checking the Twin Pulse Oscillator

Measure with the aid of the "25M" oscillograph the ... duration of the pulses and the pulse interval on the cap pin of tube 2J 11 or 2J 10 with the communication channel handle on the control panel in positions 1, 2 and 3. (A diagram of how to connect the devices is given in Fig.13).

Note: A strip of squared paper is glued on the oscillograph screen before measuring the pulse duration and interval and the scan of the oscillograph is calibrated by means of the type 27M quartz calibrator (see Fig. ...).

The duration of the pulses should range from 1 ... microsec. on the 0.5 level.

The pulse interval with the communication channel handle in position 1 should be 2 ± 0.3 microsec.

The pulse interval with the handle in position 2 should be 4 ± 0.3 microsec.

The pulse interval with the handle in position 3 should be 6 ± 0.3 microsec.

Checking the Modulator

With the aid of the type 25M oscillograph the shape of modulating pulse voltage is fed from the pulse transformer to the plate of the oscillator tube. For this end the oscillograph is coupled inductively (through a coupling coil) to the jumper connecting the pulse transformer with the plate terminal of the oscillator (Fig.15).

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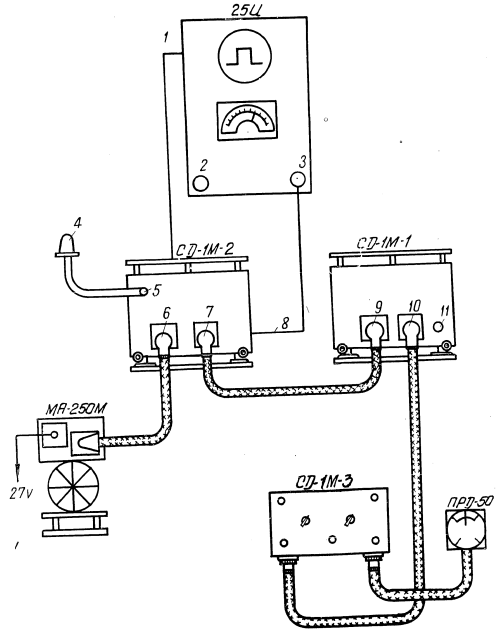

Fig. 13. Diagram showing how Apparatus is connected for checking the twin pulse oscillator. 1 - to Y-plate, 2 - input, 3 - input of synchronization, 4 - to the second contact of tube 2П II , 5 - sending antenna, 6 - power supply, 7 - receiver, 8 - to the third contact of the 2ИРЗ , 9 - transmitter, 10 - board, 11 - receiving antenna.

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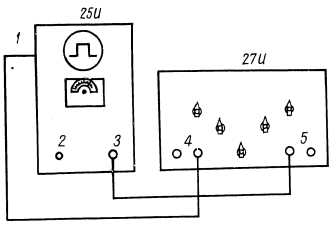

Fig.14. Diagram showing how Apparatus is connected for oscillograph calibration.
1 - to Y-plate, 2 - input, 3 - input of synchronization, 4 - calibrated output,
5 - trigger output.

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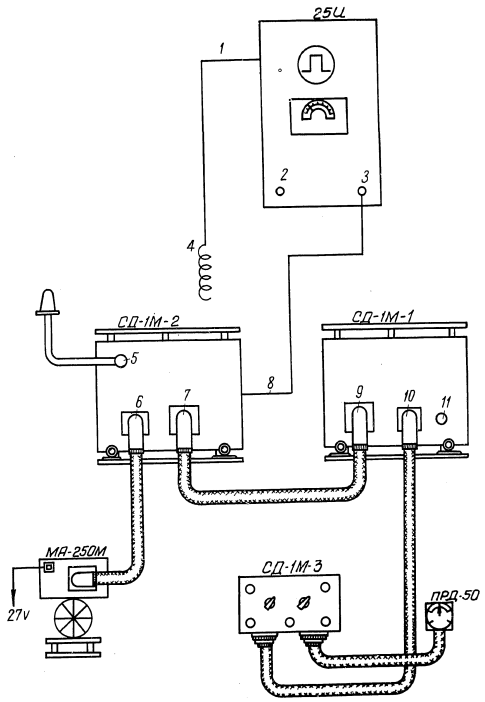

Fig. 15. Diagram showing how Apparatus is connected for checking the modulator.
1 - to Y-plate, 2 - input, 3 - input of synchronization, 4 - inductive coupling, 5 - sending antenna, 6 - Power supply, 7 - receiver, 8 - to the third contact of the 2Пр3 , 9 - transmitter, 10 - board, 11 - receiving antenna.

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Checking and Regulating and Transmitter Oscillator Frequency

1. The transmitter oscillator frequency is checked with the aid of the КИПД-5 device according to its operating instructions.

Note: The frequency should be measured not earlier than 10 min after the range finder power supply is switched on.

2. If the measurements show that the oscillator frequency differs by more than ±1 mc from the nominal value the frequency should be regulated. For this end:

3. Set the required frequency on the wavemeter scale.

4. Release the securing screw of the plug on the transmitter front panel, which covers the spline of the screw controlling the frequency (with the inscription "Frequency control").

5. Release the lock-nut from the control screw of the plate-grid circuit of the oscillator.

6. Screw in the screw if the oscillator frequency according to the preliminary measurement is higher that the nominal value, and screw it out if the frequency is lower than the nominal value, until the maximum deflection of the wavemeter pointer is obtained. If the control screw is not sufficient to ensure the nominal frequency, then, after putting it in its central position, release the lock-nut of the oscillator plate-grid circuit plunger and turn the plunger clockwise, if the oscillator frequency is lower than the nominal vule, or counterclockwise if the frequency is higher than the nominal value.

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Warning. The plate-grid circuit should be tuned with extreme care by means of a special device as there is a 1000 v voltage on the adjacent transformer.

7. After tuning has been completed tighten the lock-nuts of the plunger and the control screw so that the oscillator frequency remains within the limits of $f_{nom.} \pm 0.5$ mc, replace the plug and secure it by turning the securing screw.

Checking and Regulating the Power of the High Frequency Oscillator

The power high frequency oscillator is checked with the aid of the КИПД-5 device in accordance with its operating instructions.

The power of the oscillator should be at least 700 w.

If this is not ensured the cathode-grid circuit should be tuned. For this proceed as follows:

1. Release the screws securing the plate-grid plunger.

2. Obtain the maximum power by moving the cathode plunger.

If the transmitter power is not adequate tune the coupling of the antenna with the plate-grid circuit. For this end:

1) Release with the aid of special wrenches, supplied with the range finder in the box with spare tubes and tools, the cut flange of the high frequency coupling and the nut locking the screw from the side of the high frequency coupling.

2) Tune the coupling of the antenna with the oscillator circuit by turning the coupling loop with the aid of the screw head protruding from one side of the high frequency coupling of the transmitter.

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3. Secure with the wrench the flange of the high frequency coupling and screw in the nut, locking the screw at the slide of the high frequency coupling.

4. Fix the position of the cathode-grid circuit.

5. Fix the position of the slide of potentiometer 2R48 with the aid of its lock-nut.

6. For checking measure without fail the oscillator frequency (readjust the frequency if it has changed) and the power of the transmitter in the three communication channels.

7. If a type 25 oscillograph is on hand, the power of the transmitter oscillator may be tuned with the aim of potentiometer 2R48 to obtain the maximum possible power without distortion of the pulses on the cathode resistor (the slide of potentiometer 2R48) of the oscillator in three communication channels.

Note: If there is no type "25R" oscillograph on hand do not use potentiometer 2R48 for tuning.

5. Checking and Tuning the Receiving Part of the Receiver Unit

Intermediate Frequency Amplifier

Checking the Sensitivity of the Intermediate Frequency Amplifier

1. Extract the jumper from sockets 4 and 5 of the coupling located at the rear of the receiver chassis and connect the output indicator of the КИПД-5 set to this coupling [illegible].

During measurements with the output indicator, a [illegible] voltage (instead of the pulse voltage generated by the detector) will be fed to the control grids of [illegible]

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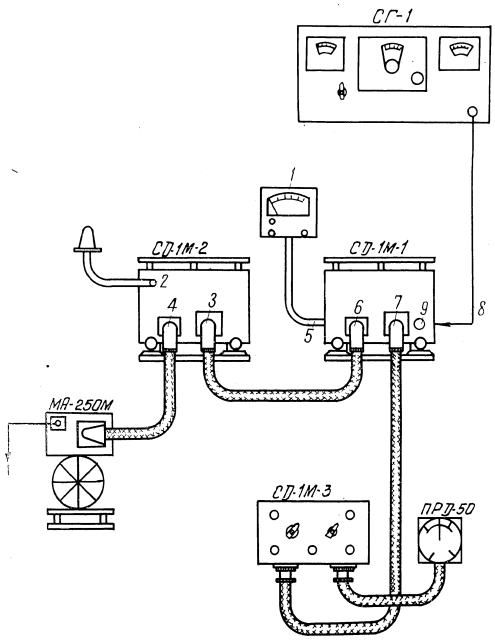

Fig. 16. Diagram showing how Apparatus is connected for checking the sensitivity of the intermediate frequency amplifier.

1 - output indicator, 2 - sending antenna, 3 - receiver, 4 - power supply, 5 - to the ШР2 coupling, 6 - transmitter, 7 - board, 8 - to the first pin of tube Л13, 9 - receiving antenna.

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intermediate frequency amplifier (IFA) and the current consumption of the receiver will increase. Tubes 1Ж11, 1Ж20, 1Ж21 and 1Ж24 should be extracted from the tube panels to unload the rectifier of the transmitter unit when the parameters of the IFA are being tested.

Warning. Each tube should be returned to its place after the measurements have been made.

2. Place the left hand tumbler switch of the output indicator in its upper position and the right hand one - in the position "Compensation".

3. Obtain a zero reading of the output indicator by turning the knob "Compensation" and then place the right hand tumbler switch in the position "Measurement".

4. Switch on the СГ-1 device and set it at a frequency of 40 mc.

The modulation is switched off.

5. Connect the output of the СГ-1 with the grid of the first tube of the IFA (the first pin of tube 1Ж3).

When doing this the conductors connection the "ground" of the cable to the receiver chassis and the СГ-1 output to the grid of the first tube should have the shortest possible length.

6. By turning the frequency setting knob of the СГ-1 with the limits of 35 to 45 mc find the position when the pointer of the output indicator will show the maximum deflection.

7. At this frequency set an output voltage of the СГ-1 at which the output indicator will show 100 microamperes.

The output voltage of the СГ-1 determines the sensitivity of the IFA. This sensitivity should be within the limits of 30 to 40 microvolts.

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9. If the required sensitivity is not obtained, this may be done by turning the slide of potentiometer 1R148. It should be remembered that in this case the noises of the receiver increase, so be very careful when increasing the receiver sensitivity by means of potentiometer 1R148.

Warning. It is strictly forbidden to turn the carbonyl cores of the IFA tuning circuit.

Checking the IFA Bandwidth

1. Connect a conductor 2 to 3 cm long to the output terminal of the CT -1 cable.

2. Bring the connected conductor toward the wire coupling the mixer cathode with the first circuit of the IFA, and press the "ground" of the cable against the chassis.

3. Having set the required output voltage of the signal oscillator (the reading of the output indicator is 100 microamperes) and having changed its tuning first in one and then in the other direction, register the frequencies at which the reading of the output indicator drops to 0.5 from its maximum value.

The bandwidth of the IFA is determined as the difference between these frequencies and it should be at least 4.0 mc.

Checking the High-Frequency Unit

Checking the Heterodyne

The deviation of the [illegible] value should not exceed 1 kc.

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The heterodyne frequency is tested with the aid of the КИП-5 device in accordance with its operating instructions. If the heterodyne frequency differs by more than ±0.5 mc from the nominal value the heterodyne should be tuned.

For this end it is necessary to release the securing screw of the plug on the front panel of the receiver, which covers the spline of the heterodyne control screw (with the inscription "[illegible]"). By turning this screw with a screw-driver, tune the heterodyne for the required frequency.

5. Replace the plug and fasten it by turning the securing screw.

Note. The noise, sensitivity of the receiver and the distance scales of the range finder are checked in accordance with the operating instructions of the КИПД-5 device.

Checking the Search Time

1. Remove the delayed pulse by disconnecting the cable from the high frequency jack "Receiving antenna" on the receiver; in this case the circuit should "search", i.e. the pointer will fluctuate at the end of the scale (the handle "Kind of operation" of the distance indicator is at the position "km", operation is being carried out on the 2nd range).

2. Check the search time with a stop-watch (the time of one complete fluctuation of the pointer). This time should constitute 1.5 to 2.2 seconds.

If the search time is beyond these limits, ensure the required search time by turning the slide of potentiometer [illegible] in the receiver unit.

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[illegible] the [illegible] of the range handle.

[illegible] the search time in the first range. It should be 1 to 1.8 seconds.

[illegible] Place the handle "kind of operation" in the "Circling [illegible]" position.

[illegible] Check the search time on circle 17. It should be 1 to [illegible] seconds.

6. Checking the Power Consumed by the Range-Finder

The d.c. power consumption of the range-finder is determined by multiplying the voltmeter readings of the ABO-5 device, which is connected to the conductors leading from the 27 v mains to the MA-250M motor-alternator, by the readings of the ammeter which is included for this purpose between the "+" terminal of the 27v mains and the positive wire leading to the motor-alternator (Fig.17).

The power consumed by the range finder should not exceed 720 w.

When the range finder is operating from a central 115v 400 cps convertor and from 27v aircraft mains the power consumption in both circuits, 115 v, 400 cps and 27v, should be checked. In this case the total power consumed from the 27 v mains should not exceed 30 w, and from the central convertor 275 va (Fig.18)

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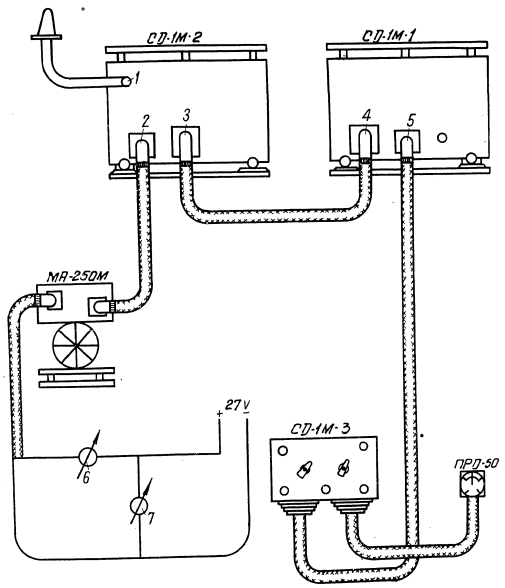

Fig. 17. Diagram showing how Apparatus is connected for checking the power consumed from 27v, aircraft mains.

1 - sending antenna, 2 - power supply, 3 - receiver, 4 - transmitter, 5 - board, 6 - ammeter, 50 amp, class 1.5, 7 - voltmeter, 30v, class 1.5.

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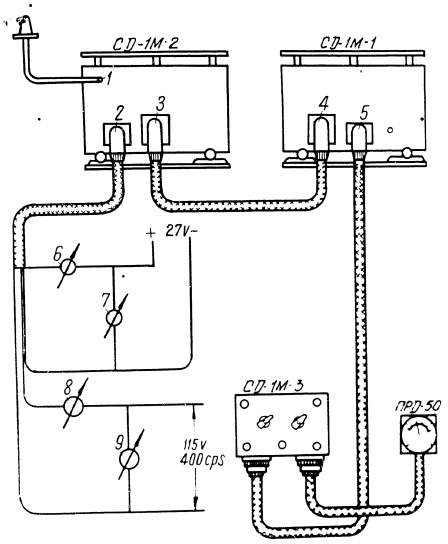

Fig. 18 Page 98.

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Chapter II

Possible Faults and How to Eliminate Them

Before removing a defective range finder from an aircraft check the state of the control and measuring devices [illegible], the switching on of the [illegible] motor-alternator from the control panel of the range finder and the intactness of the fuse on the front panel of the transmitter unit.

When a range finder is received at a shop connect it together with a KPP-I device and if the faults are confirmed remove the housings from the range finder units.

Inspect the elements of the units and check whether the elements of all the tubes get heated. If burnt resistors are traced first replace the tube in their circuit and then replace the resistors.

Check:

1. The presence of 27 v, d.c. voltage, 115 v, 400 cps, 150 v voltage, regulated voltage (with the aid of the KPP-I voltmeter);

2. The functioning of the knobs "Zero setting", "30-15 km setting", "Circling course setting";

3. The transmitter power;

4. The transmitter frequency;

5. The heterodyne frequency of the receiver;

6. The noise level at the receiver output.

Trace and eliminate the faults in accordance with the list given below.

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POSSIBLE FAULTS AND HOW TO ELIMINATE THEM

Fault	Cause	Remedy
1. The motor-alternator PU-250M does not switch on from the control panel of the range finder	1. A fuse in the circuit feeding the motor-alternator has burnt out.	Replace the fuse
	2. There is no contact in the cable or the couplings.	Check the [illegible] ness of the connecting cables
	3. The automatic interlocking system in the transmitter is not connected.	Check the reliability of the contacts in the automatic interlocking system
	4. The motor-alternator is faulty	Replace the motor-alternator
2. The motor-alternator does not switch on from the control panel of the range finder.	The contacts of the motor alternator starting relay are baked.	Replace the [illegible]
3. The lamp "on" does not light when the motor-alternator is operating. The tubes in the units do not heat. The voltmeter on the KDDM-1 device does not show voltages of 115 v and 250 v.	1. The 115 v, 3 amp fuse on the front panel of the trans-mitter has burnt out (there is no contact in the fuse socket).	[illegible]
	2. There is no contact in the cable connecting the transmitter with the range finder couplings.	Check the [illegible]

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Fault	Cause	Remedy
4. Pressing of the knobs "setting" does not influence the pointer of the distance indicator. The voltmeter on the КИД-I device does not show a voltage of 27 v, the relays in the units do not function.	1. The 27 v, 5 amp fuse on the front panel of the transmitter has burnt out; (there is no contact in the fuse socket).	Replace the fuse
	2. There is no contact in the cable or the couplings.	Check the intactness of the connecting cables.
5. The lamps on the control panel do not light when the range finder is switched on. The pointer of the distance rests on its left hand stop. Pressing of the knobs "setting" does not influence the position of the pointer. The voltmeter on the КИД-I does not show 250 v	1. One of the rectifier tubes 2Ц2, 2Ц3, 2Ц5, 2Ц6 or 2Ж7 is faulty.	Check the duty, replace the tube
	2. A voltage of 250v is not fed to the receiver unit (there is no contact in the cable or the couplings)	Check the intactness of the cable.
6. There is no "search". The pointer of the distance indicator rests on its left hand stop. The lamp "all signal" does not burn. The knobs:		

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...ult	Cause	Remedy
... setting", "3... setting" and ...ing course set... function nor...		
	The Fault is in the Transmitter Unit	
... transmitter ...s not ...diate ... power when ... faults menti... above have ...en traced.	1. The contacting shoe has been improperly inserted into the coupling on the rear wall of the transmitter.	Check the position of the contacting shoe.
	2. Tube [illegible] or [illegible] is faulty.	Check the duty, replace the tube.
... transmitter ...tes the nor... power.	1. Tube [illegible] is faulty.	Check the duty, replace the tube
	2. There is no contact in the starting impulse circuit.	Check the intactness of the cable connecting the receiver to the transmitter.
	The Fault is in the Receiver Unit	
... noise level ... the receiver output does not exceed 50 graduations when the faults mentioned above have been traced.	One of the tubes [illegible], [illegible] or [illegible] is faulty.	Check the duty, replace the tube.

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Fault	Cause	Remedy
b) The noise level exceeds 50 graduations, a normal "search" is going on when the contacting shoe is extracted.	1. There is strong, continuous, high frequency interference on the receiver frequency in the area of the tests.	Eliminate the source of interference [illegible] screen the [illegible] ne where [illegible] ing is [illegible] mud.
	2. The time selector is blocked by the receiver noises. The gain of the receiver is not properly adjusted. One of the IFA tubes [illegible]-[illegible]9 is faulty.	Reduce the noise level to normal by means of the potentiometer [illegible]. Check the duty of the IFA and replace the tube.
7. There is no "search", the pointer of the distance indicator rests on its right hand stop. The knobs: "30-150km setting" and "Circling course setting" function normally.		
a) The lamp "Call signal" is on.	1. One of the tubes [illegible] or [illegible] is faulty.	[illegible] the tube.
	2. The tuning of the "capture" range has changed.	[illegible]
b) The lamp "Call signal" is out.	One of the tubes [illegible], [illegible]7, [illegible]8 or [illegible] is faulty.	[illegible]

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Fault	Cause	Remedy
[illegible]. The pointer of the distance indicator fluctuates. The lamp "Call signal" is out.	1. The tube IЛ21 is faulty.	Check the duty, replace the tube.
	2. The neon lamp "Call signal" is faulty (there is no contact in the lamp socket).	Check the contact, replace the tube.
9. The lamp "Call signal" is on. The pointer of the distance indicator rest on its left hand or right hand stop. The knobs "Zero setting", "30-150 km setting" and "Circling course setting" do not function.	1. Tube IЛ22 or IЛ24 is faulty.	Check the duty, replace the tube.
	2. The ПРД-50 device has failed.	Replace the device
	3. There is no contact in the cable connected to the distance indicator or in its couplings.	Check the intactness of the cable
	4. The relay 1P2 does not operate or there is no contact in the contact plates of the relay.	Check the intactness of the winding circuit and the contacts of the relay (it is forbidden to bend down the contact plates).
[illegible]. The knob "Circling course setting" does not permit the ~~[illegible]~~ pointer to be placed in the middle of the " " mark of the circling	1. Tube 1Л23 is faulty	Check the duty, replace the tube.
	2. The control panel of the range finder is faulty.	Replace and send for repairs.

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Fault	Cause	Remedy
[illegible]rse scale when con-[illegible]ted for circling [illegible]eration [illegible] any circ-[illegible]. The knobs "Zero [illegible]tting", [illegible]-150 km [illegible]tting" function [illegible]mally.	3. Relays 1D3 and 1D4 do not operate or there is no contact in their contacts plates.	Check the intactness of the circuit supplying current to the relay winding and the contacts of the relay. (It is forbidden to bend down the contact plates)
11. [illegible]e "search" is normal. There is no "capture" of response signals.		
	The Fault is in the Transmitter Unit	
[illegible] The power or the frequency of the transmitter oscillator does not correspond to the nominal value or is entirely absent. In the "Control" position of the КИПД-5 "capture" is recorded.	1. The 115 v 1 amp fuse on the front panel of the transmitter has burnt out.	
	2. The twin impulse oscillator generates only one impulse. The tube 2Л11 is faulty.	Check the duty, replace the tube.
	3. The time relay 2P2 does not operate. Tubes 2Л4, 2Л1 or 2Л12 are faulty.	Check the duty, replace the tube, check the intactness of the time relay circuit.
	4. Tube 2Л13 is faulty or its parameters have changed.	Check the presence of a spark when the plate

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Fault	Cause	Remedy
		jumper has been taken off, readjust, replace the tube (after replacing the tube the oscillator should be tuned).
	The Fault is in the Receiver Unit	
a) There are no heterodyne oscillations or the heterodyne frequency does not correspond to the nominal value.	The contacting shoe has been improperly inserted. Tube LI3 is faulty or its parameters have changed.	Check the position of the contacting shoe. Replace the tube, tune the frequency.
b) There is no or little noise at the receiver output (less than 15 gradations). When starting the receiver on low frequency from the [illegible] terminal of the [illegible] device to the 3rd pin of the [illegible] coupling "capture" is recorded.	One of the tubes LI3, LI4, LI5, LI6, LI7, LI8, LI9 or LII is faulty.	Check the duty, replace the tube.
c) There is no "capture" on the high frequency but the noise at the receiver output is normal ("capture" on the low frequency is recorded).	One of the tubes LI2O, LI17 or LII4 is faulty.	Check the duty, replace the tube.

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Fault	Cause	Remedy
d)There is no "capture" both on the low and the high frequencies.	Tube 1Ж10 is faulty.	Check the duty, replace the tube.
12.The response signals are not captured on all the communication channels.	1. One of the tubes 2Ж11, 2Ж10 or 2Ж12 is faulty.	Check the duty, replace the tube.
	2. High frequency oscillator 2Ж18 has been improperly tuned. (the coupling with the antenna is too strong).	Reduce the coupling.
	3. Relays 2Р5 and 2Р4 of the communication channels do not operate.	Check the intactness of the relay winding and contacts.
13.After switching over from the first channel to the second one the distance indicator continues to show the same reading.	1. Check the intactness of the relay winding and contacts.	Relay 1Р1 "Range" does not operate
	2. The handle in the МРД-50 device is faulty.	Replace the device.

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1	1П1	Input unit		07207		
2	1К1	IFA circuit		7208/1		Input circuit
3	1К2	»		07208/2		Intermediate circuit.
4	1К3.	»		07208/3		
5	1К4	»		07208/4		
6	1К5	»		07208/5		
7	1К6	»		07208/6		
8	1К7	»		07208/7		Output circuit
9	1К8	Detector circuit		07209		
10	2Г1	Generator		07222		
11	2Ф1	Shaping circuit		07225		
12	2Ф2			07227		
13	2Ф3			07226		
14	2Ф4	Delay circuit		07224		
15	1Л1	Valve	12Х-3С		4ТУ01421-52	
16	1Л2	»	12С-3С		4ТУ01425-52	
17	1Л3		6Ж-3П		4ТУ01116-53	
18	1Л4	»	6Ж-3П		4ТУ01116-53	
19	1Л5	»	6Ж-3П		4ТУ01116-53	
20	1Л6	»	6Ж-3П		4ТУ01116-53	
21	1Л7	»	6Ж-3П		4ТУ01116-53	
22	1Л8	»	6Ж-3П		4ТУ01116-53	
23	1Л9	»	6Ж-3П		4ТУ01116-53	
24	1Л10	»	6Н-1П-В		ТС3-301-008-ТУ	
25	1Л11	»	6Н-1П-В		ТС3-301-008-ТУ	
26	1Л12	»	6Н-1П-В		ТС3-301-008-ТУ	
27	1Л13	»	6Ж-3П		4ТУ01116-53	
28	1Л14	»	6Ж-3П		4ТУ01116-53	
29	1Л15	»	6Ж-3П		4ТУ01116-53	
30	1Л16	»	ТГ1-0,1/13		4ТУ10301-53	
31	1Л17	»	6Н-1П-В		ТС3-301-008-ТУ	
32	1Л18	»	6Ж-3П		4ТУ01116-53	

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33	Л1-9	Valve	6Н-1П-В		ТС3-301-008-ТУ	
34	Л20	»	6Н-1П-В		ТС3-301-008-ТУ	
35	Л21	»	6Н-1П-В		ТС3-301-008-ТУ	
36	Л22	»	6Н-1П-В		ТС3-301-008-ТУ	
37	Л23	»	6Н-1П-В		ТС3-301-008-ТУ	
38	Л24	»	6Н-1П-В		ТС3-301-008-ТУ	
39	2Л1	»	6Ц-2С		4ТУ01308-54	
40	2Л2	»	6Ц-4М		4ТУ01224-54	
41	2Л3	»	6Ц-5С		4ТУ01224-54	
42	2Л4	»	6Ж-3П		4ТУ01116-53	
43	2Л5	»	6Ж-3П		4ТУ01116-53	
44	2Л6	»	6Г-3С		4ТУ02701-54	
45	2Л7	»	6П-3С		4ТУ01110-54	
46	2Л8	»	ТГ3-0,1/3		4ТУ1082-56	
47	2Л9	»	6Н-1П-В		ТС3-301-008-ТУ	
48	2Л10	»	ТГ3-0,1/3		4ТУ1082-56	
49	2Л1	»	ТГ3-0,1/3		4ТУ03512-55	
50	2Л12	»	ГУ-30		4ТУ1402-54	
51	2Л13	»	ГУ-116		4ТУ03244-53	
52	3Л1	Neon lamp	МН-7		ТУ-21-3-1268	
53	3Л2	»	МН-7		ТУ-21-3-1268	
54	1R1	Resistor	МЛТ-2-10-ком-11		ОЖО.467.003-ТУ	2-ВС-ВТВ-10Р
						ЗАСЕЛИ ЗАМЕНЯТЬ ТТЕ
55	1R2	«	МЛТ-0,5-680 ом-11		»	
56	1R4	«	МЛТ-0,5-4,7ком-11		»	
57	1R5	«	МЛТ-0,5-3 ком-11		»	
58	1R6	«	МЛТ-0,5-47ком-11		»	
59	1R7	«	МЛТ-0,5-200 ом-11		»	
60	1R8	»	МЛТ-0,5-1,8ком-11		»	
61	1R9	»	МЛТ-0,5-4,3ком-11		»	
62	1R10	»	МЛТ-0,5-4,8ком-11		»	
63	1R11	»	МЛТ-0,5-43 ком-11		»	
64	1R12	»	МЛТ-0,5-100ом-11		»	
65	3R3	»	МЛТ-0,5-600		»	

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66	B14	Resistor	МЛТ-0,5-1,8 ком-11	ОЖС0-467-003-ТУ	
67	1815	»	МЛТ-1-4,3 ком-1	»	
68	1816	»	МЛТ-0,5-1,8 ком-11	»	
69	1817	»	МЛТ-0,5-4,3 ком-1	»	
70	1818	»	МЛТ-0,5-100 ом11	»	
71	1819	»	МЛТ-0,5-200 ом-11	»	
72	1820	»	МЛТ-0,5-1,8 ком-11	»	
73	321	»	МЛТ-0,5-4,3 ком1	»	
74	1822	»	МЛТ-0,5-1,8 ком11	»	
75	1823	»	МЛТ-0,5-4,3 ком-1	»	
76	1824	»	МЛТ-0,5-100 ом-11	»	
77	1825	»	МЛТ-0,5-200 ом-11	»	
78	1826	»	МЛТ-0,5-1,8 ком-11	»	
79	1827	»	МЛТ-0,5-4,3 ком-1	»	
80	1828	»	МЛТ-0,5-1,8 ком-11	»	
81	1829	»	МЛТ-0,5-4,3 ком1	»	
82	1830	»	МЛТ-0,5-100 ом-11	»	
83	1831	»	МЛТ-0,5-1 ком-11	»	
84	1832	»	МЛТ-0,5-56 ком-11	ОЖС0-467-003-ТУ	
85	1833	»	МЛТ-1-4,3 ком1	»	
86	1834	»	МЛТ-0,5-1,8 ком11	»	
87	1835	»	МЛТ-0,5-4,3 ком-1	»	
88	1836	»	МЛТ-0,5-100 ом-11	»	
89	1837	»	МЛТ-0,5-1 ком-11	»	
90	1838	»	МЛТ-1-39 ком11	»	
91	1839	»	МЛТ-0,5-4,3 ком-1	ОЖС0-467-003-ТУ	
92	1840	»	МЛТ0,5-1,8 ком-11	»	Choose when adjusting
93	1841	»	МЛТ-2-3 ком-11	»	
94	1842	»	МЛТ-0,5-4,3 ком-1	»	
95	1843	»	МЛТ-0,5-10 ком11	»	Choose when adjusting
96	1844	»	МЛТ-1-91 ком1	»	
97	1845	»	МЛТ-1-200 ком-1		

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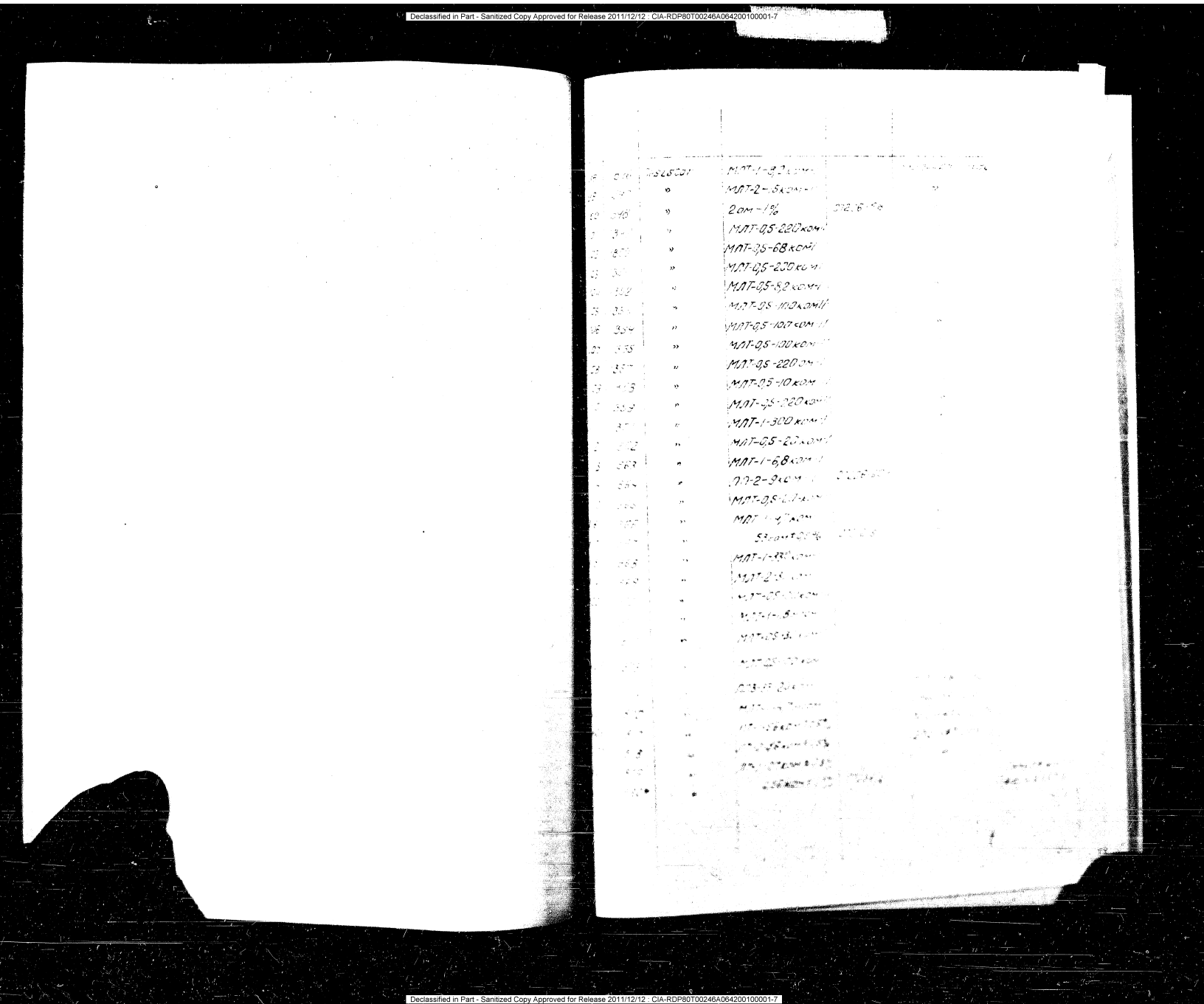

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	28	Resistor	П73-33-10 ком-11		НГХ4-685-035	
31	385	»	8 ком ±0,5%	01236/8		
32	386	»	МЛТ-0,5-1,5 ком 11		ОЖЮ-467-003-ТУ	Choose when adjusting
33	385	»	МЛТ-1-1,4 ком-11		»	
34	385	»	МЛТ-0,5-150 ком-11		»	
135	88	»	МЛТ-1-100 ком-1		»	
136	388	»	МЛТ-0,5-1,2 ком-1		»	
137	389	»	МЛТ-1-150 ком-11		»	
138	390	»	МЛТ-0,5-68 ком-1		»	
139	391	»	МЛТ-0,5-68 ком-1		»	
140	392	»	МЛТ-0,5-43 ком-11		»	
141	393	»	МЛТ-0,5-510 ком-1		»	
142	394	»	МЛТ-0,5-30 ком-1		»	
143	1395	»	МЛТ-1-1,3 мгом-11		»	
144	1396	»	МЛТ-0,5-510 ком-1		»	
145	397	»	ОП-11-2д-33А13		ОЖЮ-468-004-ТУ	
146	1398	»	МЛТ-1-10 мгом-11		ОЖО-467-003-ТУ	
147	1399	»	МЛТ-0,5-68 ком-11		»	
148	1400	»	МЛТ-0,5-220 ком 11		»	
149	18101	»	МЛТ-0,5-390 ом-1		»	
150	18102	»	МЛТ-1-10 ком-11		»	
151	18104	»	МЛТ-0,5-220 ком11		»	
152	18105	»	МЛТ-1-680 ком-1		»	
153	18106	»	МЛТ-1-100 ком-11		ОЖО-467-003-ТУ	
154	18107	»	МЛТ-0,5-20 ком11		»	
155	18108	»	МЛТ-0,5-150 ком-11		»	
156	18109	»	МЛТ-0,5-220 ком-11		ОЖО-467-003-ТУ	
157	18110	»	МЛТ-1-51 ком-1		»	
158	18111	»	МЛТ-0,5-39 ком-1		»	
159	18112	»	МЛТ-0,5-82 ком-11		»	
160	18113	»	МЛТ-0,5-220 ком-11		»	

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[illegible]	[illegible]	[illegible]	СП-11-25-22А13		ОЖСО-46[illegible]	
162	[illegible]	»	МЛТ-0,5-10 ком-11		ОЖСО-467-[illegible]-ТУ	
163	[illegible]	»	МЛТ-0,5-220 ком-11		»	
164	[illegible]	»	МЛТ-0,5-2 ком-1		»	
165	[illegible]	»	МЛТ-2-13 ком-1		»	
166	[illegible]	»	МЛТ-0,5-100 ом-1		»	
167	[illegible]	»	МЛТ-0,5-1,8 ком-1		»	
168	[illegible]	»	МЛТ-0,5-220 ком-11		»	
169	[illegible]	»	МЛТ-0,5-220 ком-11		»	
170	18[illegible]	»	МЛТ-0,5-680 ом-1		»	
171	[illegible]	»	МЛТ-0,5-3 ком-1		»	
172	[illegible]	»	МЛТ-0,5-51 ком-1		ОЖСО-467-003-ТУ	
173	[illegible]	»	МЛТ-0,5-20 ком-11		»	
174	18[illegible]	»	МЛТ-0,5-27 ком-1		»	Choose when adjusting
175	[illegible]	»	МЛТ-2-15 ком-11		»	
176	[illegible]	»	МЛТ-1-1 мгом-11		»	
177	18[illegible]	»	МЛТ-0,5-22 ком-11		»	
178	[illegible]132	»	МЛТ-1-3,9 мгом-11		»	
179	18[illegible]	»	ПТ-1-100 ком±0,5%		ВПО-467-003-ТУ	
180	18[illegible]	»	МЛТ-0,5-220 ом-11		ОЖСО-467-003-ТУ	
181	18135	»	МЛТ-1-220 ом-11		»	
182	18136	»	МЛТ-1-10 мгом-11		»	
183	18137	»	30 ком±0,5%	07212/8	»	
184	18138	»	63 ком±0,5%	07212/4	»	
185	18139	»	ППЗ-9 ком-11	07206-60/1	»	
186	18140	»	ПТ-2-27 ком±0,5%		ВПО-467-003-ТУ	
187	18141	»	МЛТ-1-1 мгом-11		ОЖСО-467-003-ТУ	
188	18142	»	МЛТ-0,5-62 ком-11		»	
189	18143	»	МЛТ-0,5-33 ком-11		»	
190	18144	»	МЛТ-0,5-15 ком-11		ОЖСО467-003-ТУ	
191	18145	»	МЛТ-0,5-20 ком-11		»	

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192	[illegible]		МЛТ-0,5-[illegible]		ОЖС0-467-003-ТУ	
193	[illegible]	»	МЛТ-0,5-330 ком-1		»	Choose [illegible] adjusting
194	[illegible]	»	СП-11-26-2,2А13		ОЖС0-468-004-ТУ	
195	[illegible]	»	СП-11-26-[illegible]А13		»	
196	3150	»	МЛТ-0,5-[illegible]		ОЖС0-467-003-ТУ	
197	[illegible]	»	МЛТ-0,5-47 ком-1		»	
198	3152	»	15 ком ± 0,5%	07212,14		
199	3153	»	18 ком ± 0,5%	07212,13		
200	23[illegible]	»	ПЛЗ-33-400 ом-11		[illegible]-685-035	
201	232	»	МЛТ-1-10 мгом-11		ОЖС0-467-003-ТУ	
202	233	»	МЛТ-1-12 ком-1		»	
203	234	»	МЛТ-1-120 ком-1		»	
204	235	»	МЛТ-1-100 ком-1		»	
205	237	»	МЛТ-0,5-24 ком-1		»	
206	238	»	МЛТ-2-6,2 ком-11		»	Check [illegible]
207	239	»	МЛТ-1-1 мгом-11		ОЖС0-467-003-ТУ	
208	23[illegible]	»	МЛТ-0,5-10 ком-11		»	
209	23[illegible]	»	СП-11-26-100А13		ОЖС0-468-004-ТУ	
210	2312	»	ПЭВ-30-5,1 ком-11		ОЖС0-447-[illegible]-ТУ	
211	2313	»	ПЭВ-10-820 ом-11		»	
212	2314	»	МЛТ-0,5-56 ком-11		ОЖС0-467-003-ТУ	
213	2315	»	ВС-1-1-120 ком-1		ОЖС0-467-004-ТУ	
214	2316	»	СП-11-26-10А13		ОЖС0-468-004-ТУ	
215	2317*	»	ВС-0,5-1-51 ком-1		ОЖС0-467-004-ТУ	Choose when adjusting
216	2318	»	МЛТ-0,5-20 ком-1		ОЖС0-467-003-ТУ	
217	2319	»	МЛТ-0,5-47 ком-1		»	
218	2320	»	МЛТ-0,5-30 ком-1		»	
219	2321	»	МЛТ-1-680 ком-11		»	
220	2322	»	МЛТ-0,5-1 ком-11		ОЖС0-467-003-ТУ	
221	2323	»	МЛТ-0,5-220 ом-11		»	
222	2324	»	МЛТ-0,5-300 ком-1		»	
223	2325	»	МЛТ-0,5-1 ком-1		»	

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224	2326		МЛТ-0,5-10 ком-1		ЭЖСО-467-003-74	
225	2327	»	МЛТ-1-680 ком-11		ОЖСО-467-[illegible]	
226	2328	»	МЛТ-0,5-220 ом-11		»	
227	2329	»	МЛТ-0,5-1 ком-1		»	
228	2330	»	МЛТ-0,5-1 ком-1		»	
229	2331	»	МЛТ-1-680 ком-11		»	
230	2332	»	МЛТ-0,5-220 ом-11		»	
231	2322	»	МЛТ-0,5-1,8 ком-1		»	
232	2334	»	МЛТ-0,5-1 ком-1		»	
233	2335	»	МЛТ-0,5-56 ком-11		»	
234	2336	»	МЛТ-0,5-220 ком-1		»	
235	2337	»	МЛТ-0,5-82 ком-1		»	
236	2338	»	МЛТ-0,5-100 ком-1		»	
237	2339	»	МЛТ-0,5-220 ком-1		»	
238	2340	»	МЛТ-0,5-30 ком-1		»	
239	2341	»	МЛТ-0,5-3 ком-1		»	
240	2342	»	МЛТ-0,5-1 ком-1		»	
241	2343	»	МЛТ-1-1 ком-11		»	
242	2344	»	МЛТ-1-1 ком-11		ОЖСО-467-003-74	
243	2345*	»	МЛТ-1-180 ом-11		»	[illegible]
244	2346	»	МЛТ-0,5-330 ком-11		»	
245	2347	»	МЛТ-1-2,2 мгом-11		»	
246	2348	»	ППЗ-33-320 ом-1		НГУ-685-[illegible]	
247	2350	»	МЛТ-0,5-750 ом-11		ОЖСО-467-[illegible]	
248	2351	»	МЛТ-0,5-100 ком-11		»	
249	381	»	985 ом ± 0,5%	07236[illegible]		
250	382	»	950 ом ± 0,5%	07236[illegible]		
251	383	»	945 ом ± 0,5%	07236[illegible]		
252	384	»	950 ом ± 0,5%	07236[illegible]		
253	385	»	840 ом ± 0,5%	07236[illegible]		

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254	3B6		3,05 ком ±0,5%	07236/11		
255	3B8		16,4 ком ±0,5%	07212/2		
256	3B10		110 ом -0,5%	07236/15		
257	3B11*			07236/23		Choose when adjusting
258	3B12	Potentiometer unit with switch	2000 ом ± 10 %	07241/3		
259	3B13	Resistor	ПТ-1-5100 ом ±0,5%		ВЭО-467-003-ТУ	
260	3B14	»	4,39 ком ±0,5%	07236/13		
261	3B15	»	1356 ком ±0,5%	07212/12		
262	3B16	Potentiometer unit with switch	1250 ом ±10%	07241/2		
263	3B17	Potentiometr unit with switches	1250 ом ±10%	07242		
264	3B18	Resistor	МЛТ-0,5-300 ком-1		ОЖСО-467-003-ТУ	
265	3B19	»	МЛТ-0,5-150 ком 11		»	
266	1C1	Capacitor		07207-60		Rated capacitance
				07207-65		
267	1C2	»	КТП-3-М-25-11		ОЖСО-460-016-ТУ	
268	1C3	»	КТП-3-М-25-11		ОЖСО-460-016-ТУ	
269	1C5	»	КПТ-4-Д-100-11		ОЖСО-460-016-ТУ	
270	1C6	»	КТП-1-С-8-11		ОЖСО-460-016-ТУ	
271	1C7	»	КТП-4-Д-100-11		ОЖСО-460-016-ТУ	
272	1C9	»	КТП-3-М-25-11		»	
273	1C10	»	КСО-1-250-Б-200-11		ОЖСО-461-015-ТУ	
274	1C11	»	КСО-1-250-Б-200-11		»	
275	1C12	»	КДК-1-М-2,5-11		ОЖСО-460-014-ТУ	
276	1C13	»	КСО-2-500-А-1000-11		ОЖСО-461-015-ТУ	
277	1C14	»	КСО-2-500-Б-220-11		»	
278	1C15	»	КДК-1-М-1,5-11		ОЖСО-460-014-ТУ	
279	1C16	»	КСО-2-500-А-1000-11		ОЖСО-461-015-ТУ	
280	1C17	»	КСО-2-500-А-1000-11		ОЖСО-461-015-ТУ	
281	1C18	»	КСО-2-500-А-1000-11		»	

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282	1019	Capacitor	КСО-2-500-5-220-1		ОЖО.460.014-ТУ
283	1020	»	КДК-1-М-1,5-11		ОЖО.460.014-ТУ
284	1021	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
285	1022	»	КСО-2-500-А-1000-11		»
286	1023	»	КСО-2-300-А-1000-11		»
287	1024	»	КСО-2-200-Б-220-1		
288	1025	»	КДК-1-М-1,5-11		ОЖО.460.014-ТУ
289	1026	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
290	1027	»	КСО-2-500-А-1000-11		»
291	1028	»	КСО-2-500-А-1000-11		»
292	1029	»	КСО-2-500-Б-220-1		»
293	1030	»	КДК-1-М-1,5-11		ОЖО.460.014-ТУ
294	1031	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
295	1032	»	КСО-2-500-А-10000-11		»
296	1033	»	КСО-1-250-А-200-11		ОЖО.461.015-ТУ
297	1034	»	КСО-2-500-А-1000-11		»
298	1035	»	КСО-2-500-Б-1000-11		»
299	1036	»	КДК-1-М-1,5-11		ОЖО.460.014-ТУ
300	1037	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
301	1038	»	КСО-2-500-А-1000-11		»
302	1039	»	КСО-2-500-А-1000-11		»
303	1040	»	КСО-2-500-Б-1000-11		»
304	1041	»	КДК-1-М-1,5-11		ОЖО.460.014-ТУ
305	1042	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
306	1043	»	КСО-2-500-А-1000-11		»
307	1044	»	КТК-2М-1,5-11		ОЖО.460.014-ТУ
308	1045	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
309	1046	»	КСО-5-500Д-2200-1		»
310	1047	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
311	1048	»	КСО-2-500-А-1000-11		»
312	1049	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
313	1050	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
314	1051	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ
315	1052	»	КСО-2-500-А-1000-11		ОЖО.461.015-ТУ

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316	1C53	Capacitor	КСО-5-500-А-2000-11		ОЖСО-461-015-ТУ	
317	1C54	»	КБГ-И-600-0,02-11		ОЖСО-462-021-ТУ	
318	1C55	»	КБГ-И-600-0,025-11		»	
319	1C56	»	КБГ-И-600-0,02-11		»	
320	1C58*	»	КСО-2-500-Г-510-1		ОЖСО-461-015-ТУ	Choose when adjusting
321	1C59	»	КСО-5-500-Г-5100-1		»	
322	1C60*	»	КСО-2-500-Г-1000-1		ОЖСО-461-015-ТУ	Choose when adjusting
323	1C61	»	КСО-5-500-Г-6800-1		»	
324	1C62*	»	КСО-5-500-Г-5100-1		»	Choose when adjusting
325	1C63*	»	КСО-5-500-Г-1200-11		ОЖСО-461-015-ТУ	Choose when adjusting
326	1C64	»	КБГ-И-200-0,02-11		ОЖСО-462-021-ТУ	
327	1C65	»	КБГ-М1-400-0,25-11		»	
328	1C66	»	КБГ-МН2-200-1-11		»	
329	1C67	»	КСО-5-500-А-2000-11		ОЖСО-461-015-ТУ	
330	1C68	»	КБГ-М1-400-0,1-11		ОЖСО-462-021-ТУ	
331	1C69	»	КБГ-М2-400-0,1-111		»	
332	1C70	»	КСО-5-500-Г-6800-1		ОЖСО-461-015-ТУ	
333	1C71	»	КБГ-И-600-0,015-11		ОЖСО-462-021-ТУ	
334	1C72	»	КСО-5-500-Г-6800-1		ОЖСО-461-015-ТУ	
335	1C73	»	КСО-5-500-А-2000-11		»	
336	1C74	»	КБГ-М1-400-0,25-111		ОЖСО-462-021-ТУ	
337	1C75	»	КБГ-МН2-200-1-111		»	
338	1C76	»	КСО-5-500-А-2000-11		ОЖСО-461-015-ТУ	
339	1C77	»	КБГ-М1-400-0,1-11		ОЖСО-462-021-ТУ	
340	1C78	»	КСО-2-500-А-150-11		ОЖСО-461-015-ТУ	
341	1C79	»	КСО-5-500-А-2000-11		ОЖСО-461-015-ТУ	Choose when adjusting
342	1C80*	»	КСО-2-500-Г-510-11			
343	1C81	»	КТК-2М-47-1		ОЖСО-[illegible]	
344	1C82	»	КСО-5-500-А-2000-11		[illegible]	
345	1C83	»	КСО-5-500-А-2000-11			

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346	1C8-	Capacitor	КБГ-И-600-0,1-11		ОЖО-462-021-ТУ	
347	1C85	»	КБГ-М2-400-0,01-11		»	
348	1C86	»	КБГ-И-400-0,03-11		»	
349	1C87*	»	КСО-5-500-А-5000-11		ОЖО-461-015-ТУ	Choose when adjustig
350	1C88	»	КБГ-М1-400-0,25-11		ОЖО-462-021-ТУ	Choose when adjustig
351	1C90	»	КБГ-М1-600-0,15-11		»	
352	1C91*	»	КСО-2-500-Г-100-1		ОЖО-461-015-ТУ	Choose when adjusting.
353	1C92*	»	КСО-5-500-Г-2000-1		»	
354	1C93	»	КСО-5-500-Г-2200-1		»	
355	1C94	»	КЭГ-2-$\frac{450}{10}$ ОМ		ОЖО-464-006-ТУ	
356	1C95	»	КСО-2-500А-1000-11		ОЖО-461-015-ТУ	
357	1C97	»	КСО-2-500-А-1000-11		»	
358	1C98	»	КСО-1-250-Б-200-11		»	
359	1C99	»	КСО-1-250-Б-200-11		»	
360	1C100	»	КСО-1-250-Б-200-11		»	
361	1C101		КСО-1-250-Б-200-11		»	
362	1C102	»	КСО-1-250Б-200-11		»	
363	1C103	»	КСО-2-500-А-1000-11		»	
364	1C104	»	КСО-2-500-А-1000-11		ОЖО-461-015-ТУ	
365	1C105	»	КСО-2-500-А-1000-11		ОЖО-462-021-ТУ	
366	2C1	»	КБГ-М2-200-0,25-11		ОЖО-464-006-ТУ	
367	2C2	»	КЭГ-2-$\frac{450}{5}$ ОМ		»	
368	2C3	»	КЭГ-2-$\frac{450}{5}$ ОМ		»	
369	2C4	»	КЭГ-2-$\frac{300}{10}$ ОМ		ОЖО-462-021-ТУ	
370	2C5	»	КБГ-М1-600-0,1-11		ОЖО-462-021-ТУ	
371	2C6	»	КБГ-М2-200-0,25-11		ОЖО-464-006-ТУ	
372	2C7	»	КЭГ-2-$\frac{450}{5}$ ОМ		ОЖО-462-021-ТУ	
373	2C8	»	КБГ-МН-2-200-1-111		ОЖО-460-014-ТУ	
374	2C9	»	КТК-2-М-51-1		»	
375	2C10	»	КТК-2-М-51-1		»	
376	2C11	»	КТК-2-М-51-1		»	
377	2C12	»	КТК-2-М-51-1			

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378	2013	Capacitor	КТК-2-М-3,9-1		ОЖО.460.014-ТУ
379	2014	»	К10-5-500-А-2400-II		ОЖО.461.015-ТУ
380	2015	»	К10-5-500-Д-5100-II		»
381	2016	»	К10-5-250-Г-10000-II		»
382	2017	»	К10-2-500-Г-150-II		»
383	2018	»	К10-2-500-А-200-II		»
384	2019	»	ОГМ-3-1000-5-150-1		ОЖО.461.003-ТУ
385	2020	»	ОГМ-3-1000-5-150-1		»
386	2021	»	ОГМ-3-1000-5-150-1		»
387	2022	»	ОГМ-3-1000-5-150-1		»
388	2023	»	ОГМ-3-1000-5-150-1		ОЖО.461.003-ТУ
389	2024	»	ОГМ-3-1000-5-150-1		»
390	2025	»	К61-М1-200-0,25-II		ОЖО.462.021-ТУ
391	2026	»	К61-М1-200-0,25-II		»
392	2027	»	К10-5-500-А-2400-II		ОЖО.461.015-ТУ
393	2028	»	КТК-2-М-36-1		ОЖО.460.014-ТУ
394	2029	»	КТК-2-М-82-1		»
395	2030	»	КТК-2-М-82-1		»
396	2031	»	КТК-2-М-82-1		»
397	2032	»	КТК-2-М-82-1		»
398	2033	»	КТК-2-М-82-1		»
399	2034	»	КТК-2-М-82-1		»
400	2035	»	КТК-2-М-82-1		»
401	2036	»	КТК-2-М-82-1		»
402	2037	»	КТК-2-М-82-1		»
403	2038	»	КТК-2-М-82-1		»
404	2039	»	КТК-2-М-82-1		»
405	2040	»	КТК-2-М-82-1		ОЖО.461.015-ТУ
406	2041	»	К10-2-500-А-300-II		ОЖО.462.021-ТУ
407	2042	»	К61-МП-2-1000-025-II		»
408	2043	»	К61-МП-2-400-025-II		
409	2044	»	33пф ±10%	11222-16	Capacitance at the indicated terminal of the VA1-2 TU-116

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410	2045	Capacitor	120пф ±5%	07222-52		Capacitors of the adjustment of the oscillator
411	2046	»	КТП-4-Д-100-II		0ЖО.460.018-ТУ	
412	2047	»	КТП-4-Д-100-II		»	
413	2048	»	КТК-2-М-82-I		0ЖО.460.014-ТУ	
414	2049	»	КТК-2-М-82-I		»	
415	2050	»	КТК-2-М-82-I		»	
416	2051	»	КТК-2-М-82-I		»	
417	2052	»	КТК-2-М-82-I		»	
418	2053	»	КТК-2-М-82-I		»	
419	2054	»	КТК-2-М-82-I		»	
420	2055	»	КТК-2-М-82-I		»	
421	2056	»	КТК-2-М-82-I		»	
422	2057	»	КТК-2-М-82-I		»	
423	2058	»	КТК-2-М-36-I		0ЖО.460.014-ТУ	
424	2059	»	КОД-2-500-Б-150-I		0ЖО.461.018-ТУ	
425	2060	»	К6Г-У-600-Д01-II		0ЖО.462.021-ТУ	
426	2061	»	К6Г-У-600-Д01-II		»	
427	2062	»	К6Г-М2-400-Д-III		0ЖО.462.021-ТУ	
428	2064	»		11207-95		
429	1Л1	Choke	Д-12-1		НТИО.412.002-ТУ	
430	1Л2	»		07208-3		
431	1Л3	Coil		07208-3		
432	1Л4	»		07208-3		
433	1Л5	»		07208-3		
434	1Л6	»		07208-3		
435	1Л7	»		07208-3		
436	1Л8	»		07208-3		
437	1Л9	»		07208-3		
438	1Л10	»		07208-3		
439	1Л11	»		07208-3		
440	1Л12	»		07208-3		
441	1Л13	»		07208-3		
442	1Л14	»				

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443	1L15	Cor7		07208-3/		
444	1L16	»		07208-3/		
445	[illegible]	»		07209-3		
446	1L18	HF Choke	950мкгн.	07283/2		
447	1L19	»	Д-1,2-1		НГЦ0-472-002-ТУ	
448	1L20	»	Д-1,2-1		»	
449	1L21	»	Д-1,2-1		»	
450	1L22	»	Д-1,2-1		»	
451	1L23	»	Д-1,2-1		»	
452	2L1	Cor7	200мкгн ±3%	07225-9		
453	2L2	»	200мкгн ±3%	07225-9		
454	2L2	»	200мкгн ±3%	07225-9		
455	2L4	»	200мкгн ±3%	07225-9		
456	2L5	»	400мкгн ±3%	07227-2		
457	2L6	»	400мкгн ±3%	07227-2		
458	2L7	»	400мкгн ±3%	07226-2		
459	2L8	»	400мкгн ±3%	07226-2		
460	2L9	»	400мкгн ±3%	07226-2		
461	2L10	»	400мкгн ±3%	07226-2		
462	2L11	»	900мкгн ±3%	07224-2		
463	2L12	»	900мкгн ±3%	07224-2		
464	2L13	»	700мкгн ±3%	07224-2		
465	2L14	»	700мкгн ±3%	07224-2		
467	2L15	»	700мкгн ±3%	07224-2		
466	2L16	»	700мкгн ±3%	07224-2		
468	2L17	»	700мкгн ±3%	07224-2		
469	2L18	»	700мкгн ±3%	07224-2		
470	2L19	»	700мкгн ±3%	07224-2		
471	2L20	»	700мкгн ±3%	07224-2		
472	2L21	»	700мкгн ±3%	07224-2		
473	2L22	»	700мкгн ±3%	07224-2		
474	2L23	Choke		07222-20		
475	2L24	»				

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476	2L25	Choke		07222-66		
477	2L26	»		07222-66		
478	2L27	Coil	700 мкгн ±3%	07224-2		
479	2L28	»	700 мкгн ±3%	07224-2		
480	2L29	»	700 мкгн ±3%	07224-2		
481	2L30	»	700 мкгн ±3%	07224-2		
482	2L31	»	700 мкгн ±3%	07224-2		
483	2L32	»	700 мкгн ±3%	07224-2		
484	2L33	»	700 мкгн ±3%	07224-2		
485	2L34	»	700 мкгн ±3%	07224-2		
486	2L35	»	700 мкгн ±3%	07224-2		
487	2L36	»	700 мкгн ±3%	07224-2		
488	2L37	»	900 мкгн ±3%	07224-2		
489	2L38	»	900 мкгн ±3%	07224-2		
490	1T1	Heating transformer		07210		
491	2T1	Transformer power transformer		07231		
492	2T2			08295		
493	2T3	Blocking-oscillator transformer		07229		
494	2T4	Pulse transformer		08259		
495	1P1	4 poles relay in 2 directions	РМУГ-4п		РС4-523-402	
496	1P2	2 poles relay in 2 directions	РМУГ-2п		РС4-523-406	
497	1P3	4 poles relay in 2 directions	РМУГ-4п		РС4-523-402	
498	2P1	Barometric relay with microswitch		07221-9		
499	1P4	4 poles relay in 2 directions	РМУГ-4п		РС4-523-402	
500	2P2	2 poles relay in 2 directions		07230/2	РС4-523-406	
501	2P3	»	РМУГ-2п		РС4-523-406	
502	2P4	»	РМУГ-2п		ГОСТ-5010-53	+276
503	2ПР1	Fuse	ПЦ-30-3		»	ИБ 2.400-4.
504	2ПР2	»	ПЦ-30-3			

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505	ПР3	Fuse	ПЦ-30-1		ГОСТ-5010-53	1156 [illegible]
506	1ШР1	Block		07207-80		
507	1ШР2	Contact Block		07221-56/2		
508	1ШР3	Block part of the jack for 20 contacts with receptacles	ШР-48-Ч20ЭГ-1		ВПО-364-010	Socket
509	1ШР4	ditto for 12 contacts with pins	ШР-32-Ч1-2ЭШ-1		»	Plug
510	2ШР1	ditto for 12 contacts with receptacles	ШР-32-Ч1-2ЭГ-1		»	Socket
511	2ШР-2	ditto for 6 contacts with pins	ШР-28-Ч6-ЭШ5		»	Plug
512	2ШР3	Contact Block		07221-56/1		
513	2ШР4	HF jack of oscillator				Acc. drawing
514	3ШР1	Block part of the jack for 20 contacts with pins	ШР-48-П20-ЭШ1		ВПО-364-010	Plug
515	3ШР2	ditto for 6 contacts with receptacles	ШР-28-П6-ЭГ4		»	[illegible]
516	2Г1	Receptacle			ВКС-[illegible]	
517	2Г2	»			»	
518	2М1	Motor ventilator	2Д-7			
519	1А1	Receiving antenna		07246		
520	2А1	Transmitting antenna		07246		
521	М1	Motor alternator МА-230М one frame		[illegible]		

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505	ПР3	Fuse	ПЦ-30-1		ГОСТ-5010-53	1156 400
506	1ШР1	Block		07207-80		
507	1ШР2	Contact Block		07221-56/2		
508	1ШР3	Block part of the jack for 20 contacts with receptacles	ШР-48-420ЭГ-1		ВПО-364-010	Socket
509	1ШР4	ditto for 12 contacts with pins	ШР-32-41-2ЭШ-1		»	Plug
510	2ШР1	ditto for 12 contacts with receptacles	ШР-32-41-2ЭГ-1		»	Socket
511	2ШР-2	ditto for 6 contacts with pins	ШР-28-46-ЭШ5		»	Plug
512	2ШР3	Contact Block		07221-56/1		
513	2ШР4	HF jack of oscillator				Acc drawing
514	3ШР1	Block part of the jack for 20 contacts with pins	ШР-48-П20-ЭШ1		ВПО-364-010	Plug
515	3ШР2	ditto for 6 contacts with receptacles	ШР-28-П6-ЭГ4		»	Socket
516	2Г1	Receptacle			ВЖС6-504-002	
517	2Г2	»			»	
518	2М1	Motor ventilator	2Д-7			
519	1А1	Receiving antenna		07246		
520	2А1	Transmitting antenna		07246		
521	М1	Motor alternator MA-250M one frame		ПЧ-0-800		

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S22		Range	1212-60		
S23		Communication wiring		07207-84	
S24	142	Sine v1		07207-30	
S25	A43	Communication wiring		07207-17	
S26	144	Sine v2		07207-46	
S27	181	Button switch		FP3-604-005	
S28	182	One pole change-over switch in 5 directions		04163	
29	333	3 pole change-over switch in 3 directions		7238	

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Fig.19. General Schematic Diagram of Type CA-IM Range Finder.

1 - Receiving antenna,
2 - heterodyne,
3 - to heating circuit,
4 - high frequency amplifier detector IF1
5 - 1st stage of IFA,
6 - 2nd stage of IFA,
7 - 3rd stage of IFA,
8 - 4th stage of IFA,
9 - 5th stage of IFA,
10 - 6th stage of IFA,
11 - 2nd detector,
12 - 1st LFA, 2nd LFA,
13 - 3rd LFA, and cathode follower,
14 - keep-relay,
15 - receiver and selector unit,
16 - to heating circuit,
17 - charging stage
18 - "setting" relay,
19 - "range" relay,
20 - charge storage,
21 - discharging tube,
22 - discharging thyratron,
23 - amplifier-limiter,
24 - cathode follower,
25 - amplifier limiter,
26 - "search" tube,
27 - amplifier limiter,
28 - code keep-relay,
29 - cathode follower,
30 - charging diode,
31 - d.c. amplifier,
32 - metering tube,
33 - "kind of operation" relay,
34 - "kind of operation" relay,
35 - sending antenna,
36 - "channel of communication" relay,
37 - microwave oscillator,
38 - modulator,
39 - stages of interrogation twin pulse generators,
40 - blocking oscillator,
41 - stages of single pulse generator,
42 - voltage stabilizer,
43 - rectifier,
44 - transmitter and supply unit,
45 - MA-250M motor-alternator,
46 - diagram of transmitter unit tube of filament connection,
47 - diagram of receiver unit tube of filament connection
48 - to the jack of position IMP4
49 - distance indicator,
50 - circling courses,
51 - on,
52 - call signal,
53 - control panel,
54 - kilometers,
55 - readjustment,
56 - zero setting,
57 - 30-150km setting,
58 - circling course setting,
59 - communication channel,
60 - off,
61 - range finder.

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Fig.20. Overall Dimensions and Assembly of Type VAI-4 Range Finder

1 - transmitter,
2 - be careful, 10 kv,
3 - power supply,
4 - receiver,
5 - board,
6 - detector,
7 - heterodyne,
8 - receiver antenna,
9 - receiving antenna,
10 - distance indicator,
11 - control panel,
12 - circling, KM,
13 - view along arrow V,
14 - sending antenna,
15 - view along arrow A,
16 - view along arrow B,
17 - openings,
18 - to aircraft mains,
19 - power supply set MA-250M,
20 - marking of fastenings (along arrow A), view along arrow B.

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Table to fig.20.

Item No.	Designation in diagram	Item	Designation number	Remarks
15		Cable 1	07205	
14		Shield	72000 Fig 2	
13		Shield	72000 Fig 1	
12		Antenna feeder 6	07259 1/1	
11		Antenna feeder 7	07250 1/2	
10		Cable 5	07257	
9		Cable 4	07259	
8		Cable 3	07255	
7		Cable 2	07204	
6		Motor-alternator on frame	I 4000	
5		Antenna		2 pieces
4		MMI-50 device		finished article
3		General view of GI-IM-3 instrument	07249	
2		Transmitter GI-IM-3	07221	
1		Receiver GI-IM-1	07206	

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Notes to fig.20.

When arranging the equipment on a plane the following should be borne in mind:

1. As a result of jolts the devices may be thrown upward up to 5 mm, and rocked to either side to 12 mm.

2. When removing the devices from their shock absorbing frame they should be moved forward up to 20 mm and lifted upward 10 mm, after which they can be removed to any side.

3. The overall dimensions of the receiver and the transmitter are identical.

4. At the place where the distance indicator (position 4) is to be installed shields (positions 13 and 14) should be put in place as shown in the drawing.

5. The dimensions shown are for assembly.

6. The cables, positions 7, 8, 9, 10, 11, 12 and 15, are shown conditionally.

7. Each CA-IM range finder is supplied with a set of cables corresponding to the plane for which the given range finder is intended (agreed with the Customer and the Manufacturer).

8. The total weight of the range finder without the set of cables and the motor-alternator is 22 kg.

9. The length of antenna feeders 6 and 7 is at least 0.5 m and at most 3 m (this is defined more exactly when planning of the equipment on the plane).

10. The length of cables 1, 2, 3, 4 and 5 is at least 0.5 m (this is defined more exactly when planning the arrangement of the equipment on the plane). The length of cable 3 is not over 6 m, and that of cable 4 is not over 30 m.

11. A new model of the equipment is introduced after positive testing with the new feeders and cables.

12. The receiver unit CA-IM-1 and the transmitter unit CA-IM-2 should be mounted on shock-absorbing frames bearing the corresponding inscriptions.

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3. Compliment list

Item Nos	Name	Drawing No	No-off		Packed in:
1	Device CA-IM-1	07206	1	07200-1	
2	Device CA-IM-2	07221	1	07200-3	
3	Device CA-IM-3	07240	1	07200-5	
4	Device ПРД-50	wares	1	07200-41	
5	Box with spare gear	07201	1		Box
6	Shield	072000PM-1	1	07200-41	No 1
7	Shield	072000PM-2	1	07200-41	07200
8	Aircraft aerial		2	07200-36	
9	Receiving aerial feeder 6	07250-1/1	1		
10	Transmitting aerial feeder 7	07250-1/2	1		
11	Cable 1	07203	1		
12	Cable 2	07204	1	07200-14	
13	Cable 3	07255	1		
14	Cable 4	07259	1		
15	Cable 5	07257	1		
16	Motor-alternator MA-250M ona frame	A1-0-000	1	07200-20	Box No 2 07205

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1. SET OF SPARE PARTS AND ACCESSORIES

Item: Nos :	Denamination	Type	Drawing N	Q-ty
1	Valve	I2X-3C		2
2	Valve	I2Д-3C		2
3	Valve	6Ц-5C		1
4	Valve	СГ-3С		1
5	Valve	ГИ-30		1
6	Valve	ГИ-IIБ		2
7	Valve	ТГI-0.I/I.8		1
8	Valve	ТГ3-0.I/I.8		1
9	Valve	6Н-IП-В		6
10	Valve	6Ж-3Н		6
11	Valve	2Ц-2С		1
12	Valve	5Ц-4М		1
13	Valve	6Ц-3С		2
14	Neon lamp	МН-7		2
15	Fuse	ПЦ-3-30		15
16	Fuse	ПЦ-I-30		10
17	Take off device		07201-31	1
18	Special screw driver		07201-32	1
19	Special screw driver		07201-33	1
20	Special ~~key~~ wrench		07201-34	1
21	Locling unit		07201-44	1
22	Socket ~~xxxx~~ wrench		07201-47	1
23	Special ~~wrench~~		07201-50	1
24	Screw driver		07201-52	1
25	Anode output		07222-16	1
26	Screw driver		ВЖ4.063.001	1
27	Key		07201-55	1
28	Special screw driver (for the ПРД-50 device)		07201-60	2
29	Sponge			1
30	Spare parts and accessories for motor 2Д-7			According to a list
31	ditto for the motor-alternator МА-250М			
32	Bushing		07222-45	2

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Appendix

Translation of the Russian Inscriptions
on the Type СД-IM Aircraft Range Finder into English

Питание	Power supply
Приемник	Receiver
Передающая антенна	Sending antenna
Передатчик	Transmitter
Щиток	Panel
Антенна приемная	Receiving antenna
Дальномер	Range finder
Орбиты	Circling courses
Перестройка	Readjustment
Установка нуля	Zero setting
Установка орбит	Circling course setting
Установка 30-150 км	30-150 km setting
Позывной сигнал	Call signal
"Включено"	"on"
Диапазон	Range
Род работ	Kind of operation
Канал связи	Communication channel
"Сет.115 в"	115 v setting
"Измерение дальности"	"Distance measuring"
"Выкл."	"off"
"Задержка, км"	"Delay, km"
"Калибр. имп-контроль"	Calibr.pulse control
"Орбитирование"	Circling
"Борт.сеть-накал"	"Aircraft mains-heating"
Накал	"Heating"
Регулировка накала	"Heating control"
Род измерений, вольтметр	"Kind of measurements,v. meter"

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Контроль, 300 в, 30 в	Control, 300 v, 30 v
Проверка СД-IM, ~ 150 в	СД-IM control, ~ 150 v
Частота Б.чувств.	Freq.high sensitive
Частота мгтц	Frequency, mc
Частота М.чувств.	Freq.low sensitive
Чувствительность	Sensitivity
Мощность, 300 в	Power - 300 v
Мощность ватт	Power, w
Подстройка частоты	Frequency control
Компенсация	Compensation
Измерение	Measurement
АВО-5 device	Ampere-Volt-Ohmmeter

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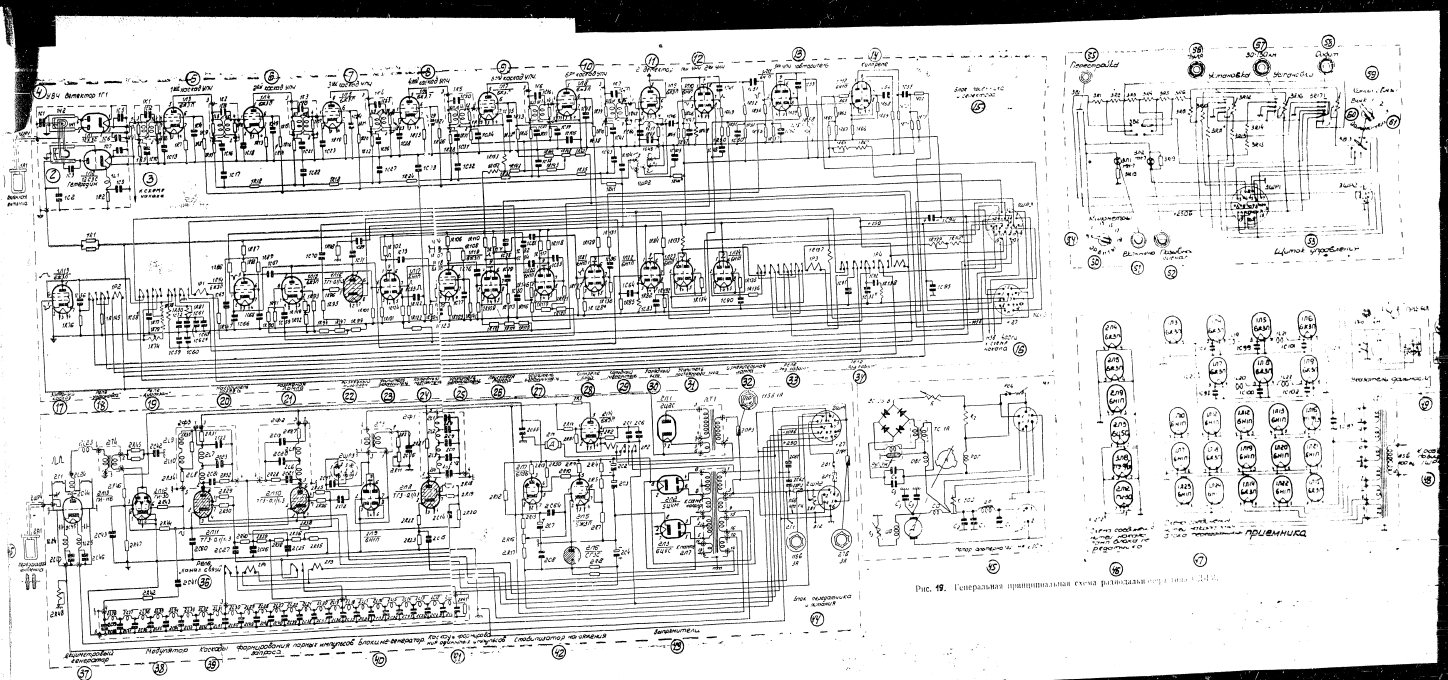

Рис. 19. Генеральная принципиальная схема радиоприемника

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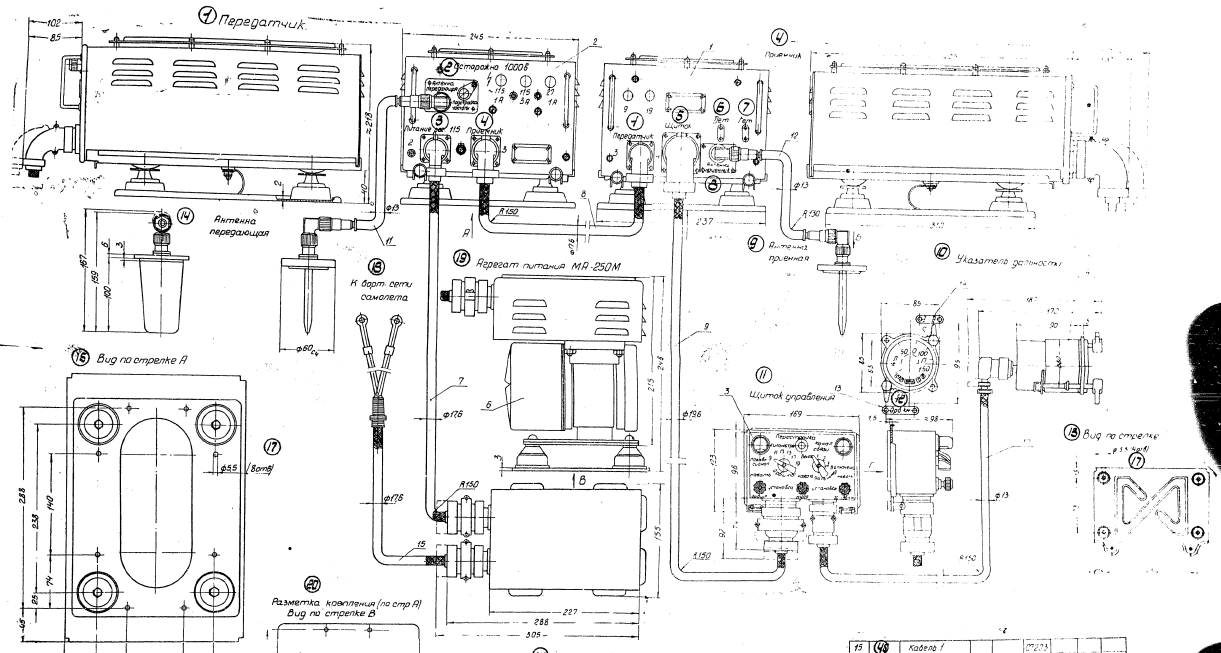

46 ПРИМЕЧАНИЯ

При размещении на самолете необходимо иметь в виду:

1. При тряске приборы может подбросить вверх до 5 мм, качать в сторону 12 мм.
2. При съемке с амортиз. рам приборы необходимо подать вперед до 20 мм и поднять вверх на 10 мм, после чего их можно снимать в любую сторону.
3. Габариты приемника и передатчика одинаковы.
4. В месте установки указателя дальности (поз 4) установить шильдики поз 13, 14 как указано на чертеже.
5. Размеры установочные.
6. Кабели поз. 7, 8, 9, 10, 11, 12, 15 показаны условно.
7. В каждую станцию СД-1М входит согласованный с заказчиком и заводом-изготовителем комплект кабелей, соответствующий типу самолета для которого предназначена данная станция.
8. Общий вес станции без комплекта кабелей и без мотора альтернатора 22 кг.
9. Длина фидеров антенны 6 и 7 не менее 0,5 метра и не более 3-х метров (уточняется при согласовании размещения аппаратуры на самолете).
10. Длина кабелей 1, 2, 3, 4 и 5 не менее 0,5 метра (уточняется при согласовании размещения аппаратуры на самолете). Длина кабеля 3 не более 6 метров. Длина кабеля 4 не более 30 метров.
11. Введение нового литера изделия производится после положительных испытаний станции с вводимыми фидерами и кабелями.
12. Блоки приемник СД1М-1 передатчик СД1М-2 должны быть установлены на амортизационных рамах с соответствующей маркировкой на них.

NN п/п	Обозначение по схеме	Наименование	Тип	Данные	Шифр	N° черт	ГОСТ	Примеч
21	22	23	24	25	26	27	28	29
15	49	Кабель 1			07203			
14	44	Шильдик			72000-2			
13	44	Шильдик			72000-1			
12	48	Фидер антенны 6			07259 1/2			
11	42	Фидер антенны 7			07250 1/2			
10	41	Кабель 5			07257			
9	40	Кабель 4			07259			
8	39	Кабель 3			07255			
7	38	Кабель 2			07204			
6	37	Мотор-альтернатор на раме			40000			
5	36	Антенна			07246			2 шт.
4	35	Прибор ПРД-50						Гост. изд.
3	34	Общий вид прибора СДТ М-3			07240			
2	33	Передатчик СДТ М-2			07221			
1	32	Приемник СДТ М-1			07206			

Рис. 20. Габаритно-монтажная схема радиодальномера типа СД-1М

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[redacted]

Description and operating instructions of glige-slope and course radio receivers types RPN-2 and RPN-4 designed for operation in "CN-SO" and „ILS" systems.

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[redacted]

D E S C R I P T I O N

AND OPERATING INSTRUCTIONS

OF GLIDE-SLOPE AND COURSE RADIO RECEIVERS

TYPES KPM-2 and KPM-4 DESIGNED

FOR OPERATION

IN "CH-50" and "ILS" SYSTEMS

- 1960 -

50X1-HUM

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[illegible]

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II. Operating principle 13

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Block diagram of the КРП-Ф radio receiver . . 17

Principle of operation and constructional features of the type АП amplitude attachment 21

III. Operation of the circuit 25

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V. Description of the units of the ГРП-2 and КРП-Ф 62

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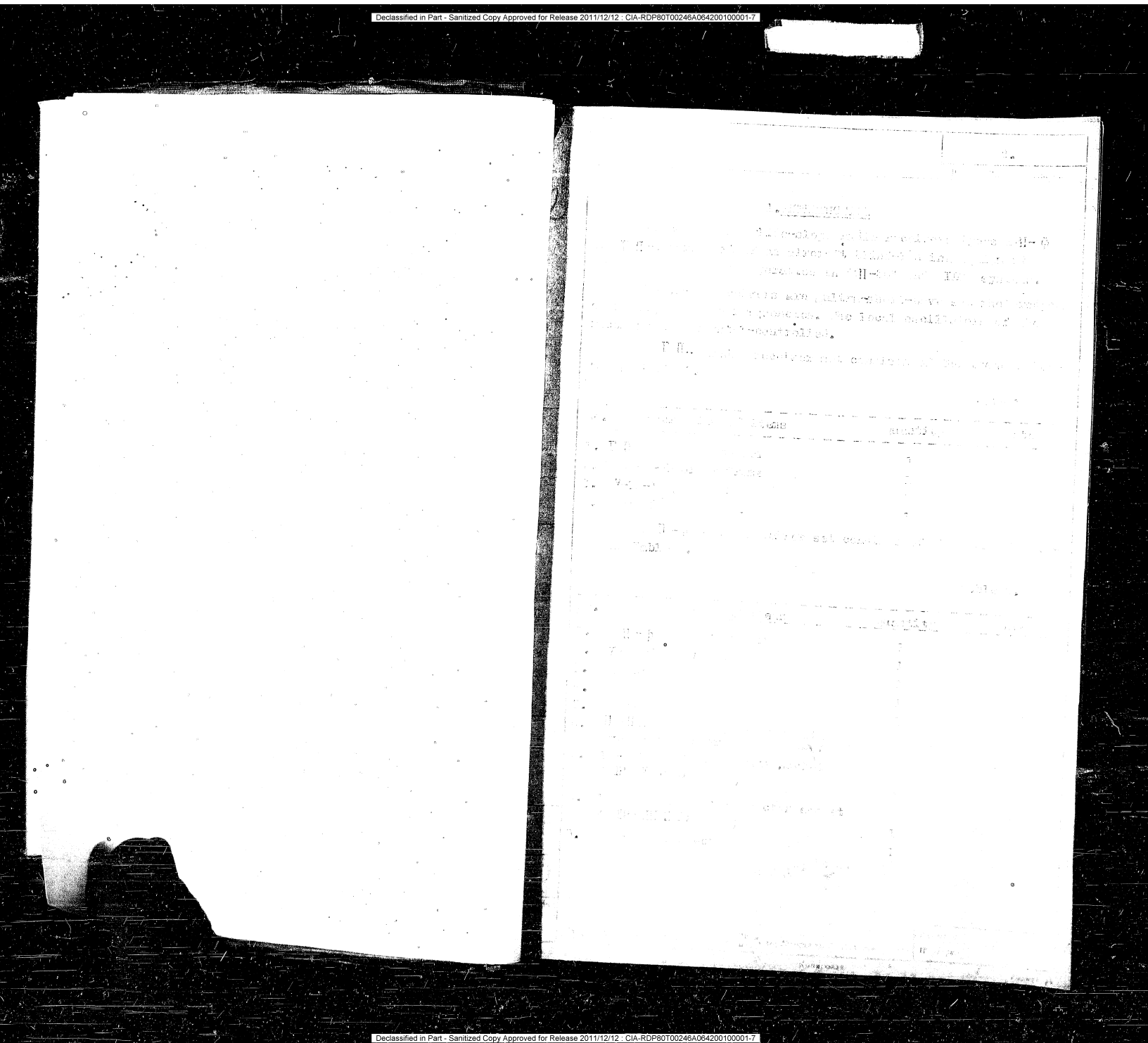

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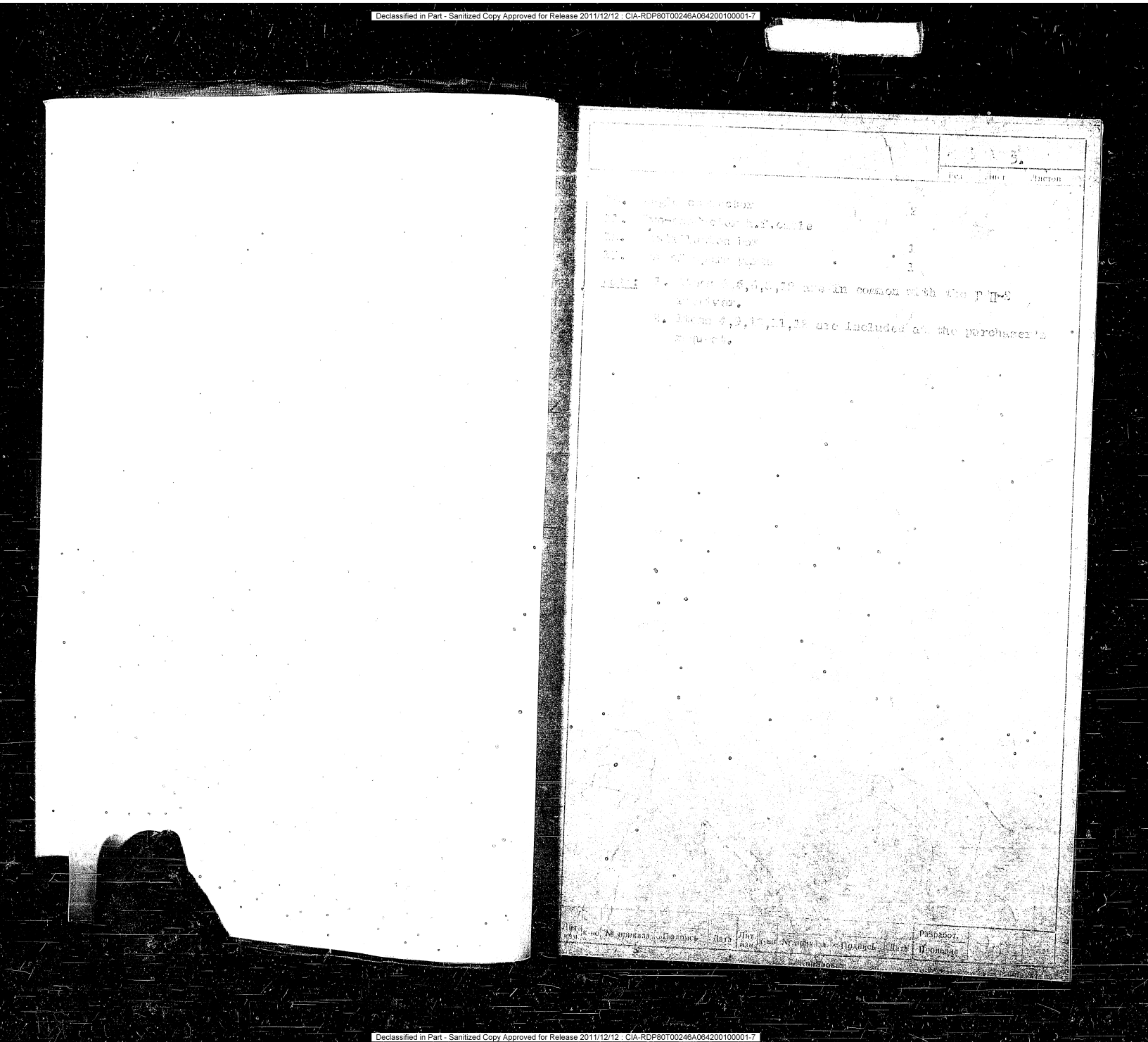

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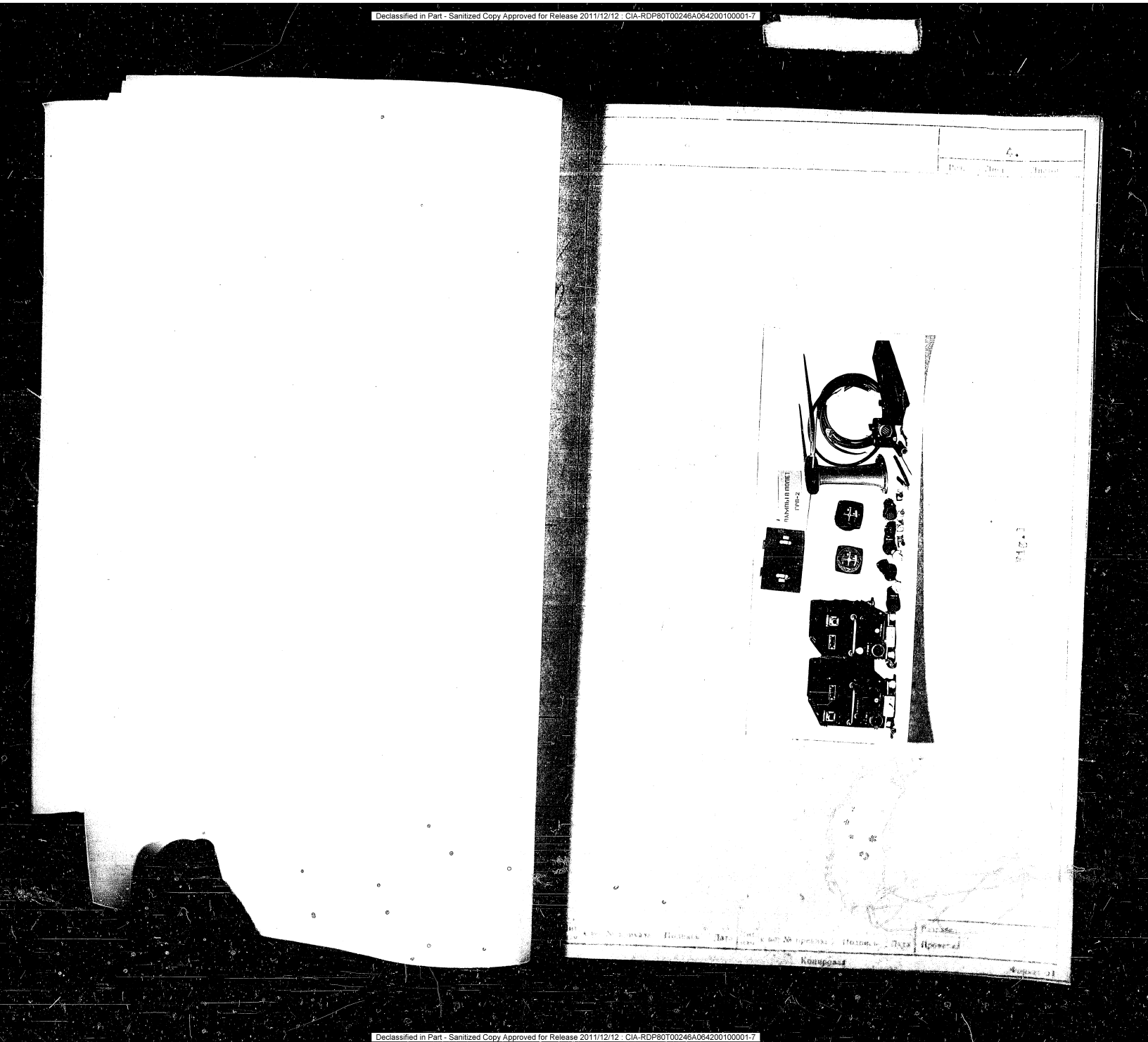

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10.	Angle connector	2
11.	Two-conducter h.f.cable	
12.	Distribution box	1
13.	Box of spare parts	1

Note: 1. Items 4,5,6,8,12 are in common with the ГРП-2 receiver.

2. Items 4,9,10,11,12 are included at the purchaser's request.

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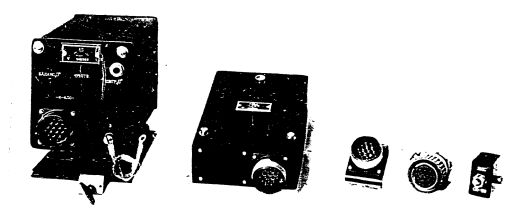

Fig.2. Top view of receiver chassis

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The units of the aircraft blind-landing equipment are connected as shown in the diagram of cable connections [illegible] "СП-50": Appendix No.[illegible] for a set operating with [illegible] appendix No.3 for a set operating with the indicator, appendix No.14 for a set operating with a capacitor unit (Б). System "СП-50-[illegible]", appendix No.1[illegible] for a set operating with the indicator; (appendix No.16 for a set operating with two indicators).

The ГРП-8 radio receiver is designed for receiving the signals of a glide-slope radio beacon and indicating aircraft the glide path to.

The КРП-ф radio receiver is designed for receiving signals of a course-line radio beacon and indicating the middle line of the take-off and landing strip (course line) to aircraft.

The output indicator of the КРП-ф and ГРП-8 receivers is a ПСП-48 device. Should the need arise, the КРП-ф and ГРП-8 radio receivers can operate with two ПСП-48 indicators. Signals from the output of the ГРП-8 radio receiver are applied to the horizontal pointer of the two-pointer indicator, type ПСП-48, which is designed for indicating the position of the aircraft with respect to the glide-slope line. If the aircraft is below the glide-slope line, the indicator pointer deflects up, if the aircraft is above the glide-slope line, the indicator pointer deflects down, i.e. when the aircraft is not on the glide-slope line the pointer indicates the direction to the glide-slope line. When flying right on the glide-slope line, the horizontal pointer of the ПСП-48 indicator is located on the line formed by a horizontal row of white dots on the indicator scale.

In a similar way, the vertical pointer of the ПСП-48 indicator [illegible] the position of the aircraft with respect to the course line. When the aircraft deflects to the right, the indicator pointer deflects to the left, when the aircraft deflects to the left, the indicator pointer deflects to the right.

Normal operation of the glide-slope and course radio receivers is indicated by the emergency signalizer. The emergency

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signalizer of the glide-slope receiver is located in the right-hand part of the indicator scale over the horizontal row of [illegible] dots. The emergency signalizer of the course radio receiver is located to the right of the vertical row of white indicator [illegible]. The white window of the emergency signalizer is [illegible] flap (the same colour as the scale) only when there is a [illegible] and the receiver is operating normally. If the signalizer [illegible] is shut by a white flap, there is no signal, or the [illegible] out of order and cannot be used.

The ГП-2 receiver operates on three fixed frequencies, КРП-Ф receiver on six fixed frequencies. The fixed frequencies are switched without re-tuning the receiver by connecting the corresponding crystals which control the frequency of the local oscillator. The crystals are switched by remote control from the control panel simultaneously for the glide-slope and course receivers. The various switch positions correspond to the following fixed frequencies of the glide-slope and course receivers (see Table 4 for the "СП-50" system) and Table 5 for the [illegible] system).

Table 4

Switch position	Fixed-frequency number of the ГП-2 receiver	Fixed-frequency number of the КРП-Ф receiver
1	1	1
2	1	2
3	2	3
4	2	4
5	3	5
6	3	6

Table 5

Control panel switch position	Fixed-frequency number of КРП-Ф receiver	Fixed-frequency number of ГП-2 receiver	Note
1	2	3	4
1	1	1	

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Формат а1

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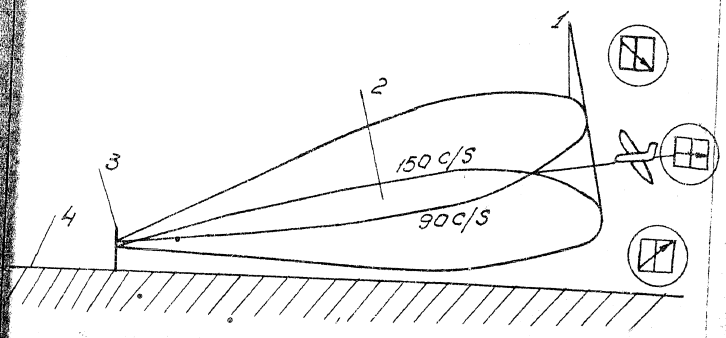

[illegible] glide-slope radio beacon
1. Directional radiation lobes of glide-slope radio beacon antenna. 2. Equisignal zone 3. Antenna of glide-slope radio beacon 4. Landing strip.

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[illegible] beacon consists of [illegible] vertical planes. The directivity [illegible] selected such [illegible] radiation lobes correspond [illegible]). When flying along the [illegible] from both lobes at the [illegible] the aircraft deflects up or down [illegible] the signal of the upper or lower lobe, res- [illegible] receiver input.

[illegible] of the upper and lower lobes of the glide- [illegible] differ not only in directivity, but [illegible] frequency in the "П-50" system, the upper [illegible] by a frequency of 150 c/s and the lower lobe [illegible] c/s, i.e. above the equisignal zone, a sig- [illegible] c/s [illegible], and below the zone a sig- [illegible] in the "[illegible]" system, on the other hand, [illegible] by a frequency of 90 c/s, and the [illegible] flying in the radiation zone of the [illegible] the glide-slope receiver receives two [illegible] frequency: one signal modulated by [illegible] by a frequency of 150 c/s. In [illegible] audio frequency amplifier of the [illegible] signals of two frequencies: 90 and 150 c/s. [illegible] the aircraft with respect to the [illegible] (glide-slope line) these signals can be equal [illegible] the glide-slope line) or one can be greater [illegible] (affecting from the glide-slope line).

[illegible] consisting of narrow-band audio-frequency filters [illegible] rectifier circuits, located at the receiver out- [illegible] possible to separate the signals having frequencies [illegible] c/s, to rectify each one separately and to compare [illegible] rectified currents in the П-П- 48 indicator.

[illegible] currents obtained on rectification of the [illegible] signals affect the horizontal pointer of the indi-

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sector. When flying in the equisignal zone, the signals having frequencies of 90 and 150 c/s are equal and the indicator pointer does not deflect. If the signal of 90 c/s is greater than that of 150 c/s, the indicator pointer in the "SCH-50" system deflects up (the equisignal zone is higher), and if the 150 c/s signal predominates the indicator pointer deflects down (the equisignal zone is below). In the "ILS" system, when the 90-c/s signal predominates, the indicator pointer deflects down and when the 150-c/s signal predominates the pointer deflects up. In addition, the rectified currents of both the 90 and 150 c/s signals pass through the winding of the emergency signalizer, causing the black side of the flap to turn to the window.

The antenna of the RPL-2 receiver is a half-wave dipole and is constructionally incorporated with the antenna of the course leading receiver. Apart from the indicated combination of antennas, the glide-slope receiver can operate from a special antenna which is made by the aircraft works together with the aircraft.

The receiving antenna of the RPL-5 receiver receives the signals of the course beacon. In the "SCH-50" blind-landing system the radiation of the course beacon (Fig.4) contains two components:

1) directional radiation

2) non-directional circular radiation.

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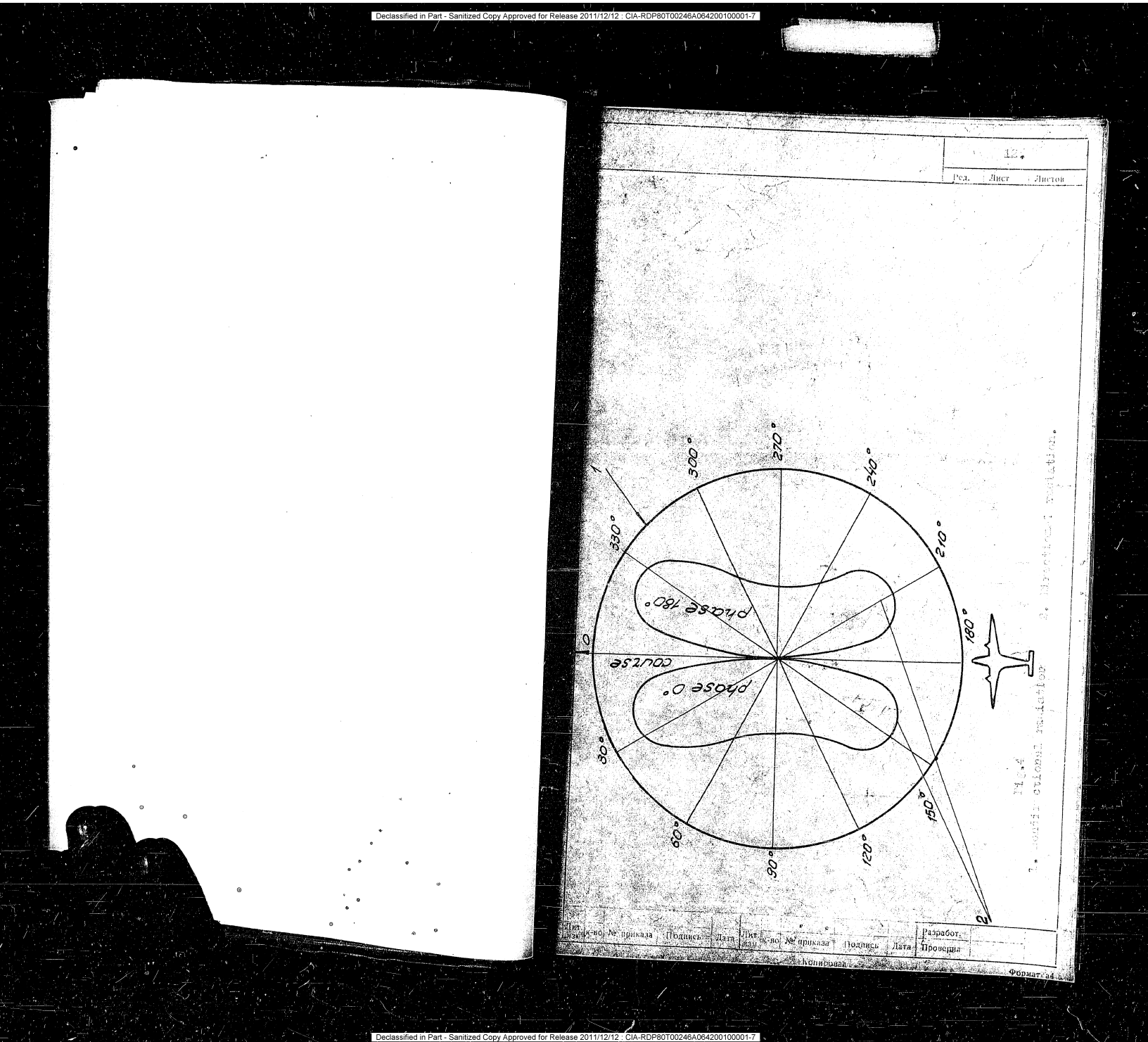

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The directional radiation [illegible] beacon [illegible] in the horizontal plane, the [illegible] between which is [illegible] course line. The directional radiation is an ultra-high frequency signal ([illegible]) amplitude modulated by an audio frequency voltage of [illegible] c/s. The modulating voltages of the two zones are in antiphase.

The non-directional circular radiation is a signal of the same ultra-high frequency modulated in amplitude by an auxiliary subcarrier having a frequency of 10,000 c/s. The subcarrier frequency is in turn frequency modulated by 60 c/s with frequency deviation of ± [illegible] c/s.

The use of an auxiliary subcarrier frequency of 10,000 c/s and frequency modulation is due to the need of individually separating out in the receiver of both 60-c/s modulating voltages, contained in the directional and non-directional radiations.

The phase of the 60-c/s voltage which frequency modulates the subcarrier, is the same at any point in the space around the beacon and is inphase with the modulating voltage of one zone and in antiphase with the modulating voltage of the other zone of the directional radiation of the beacon.

The directional radiation, the phase of the modulating voltage of which changes its sign when the aircraft passes from one zone to the other, we shall term the variable-phase radiation.

Oscillograms of the constant-phase and variable-phase radiation signals are shown in Fig. b, a and b.

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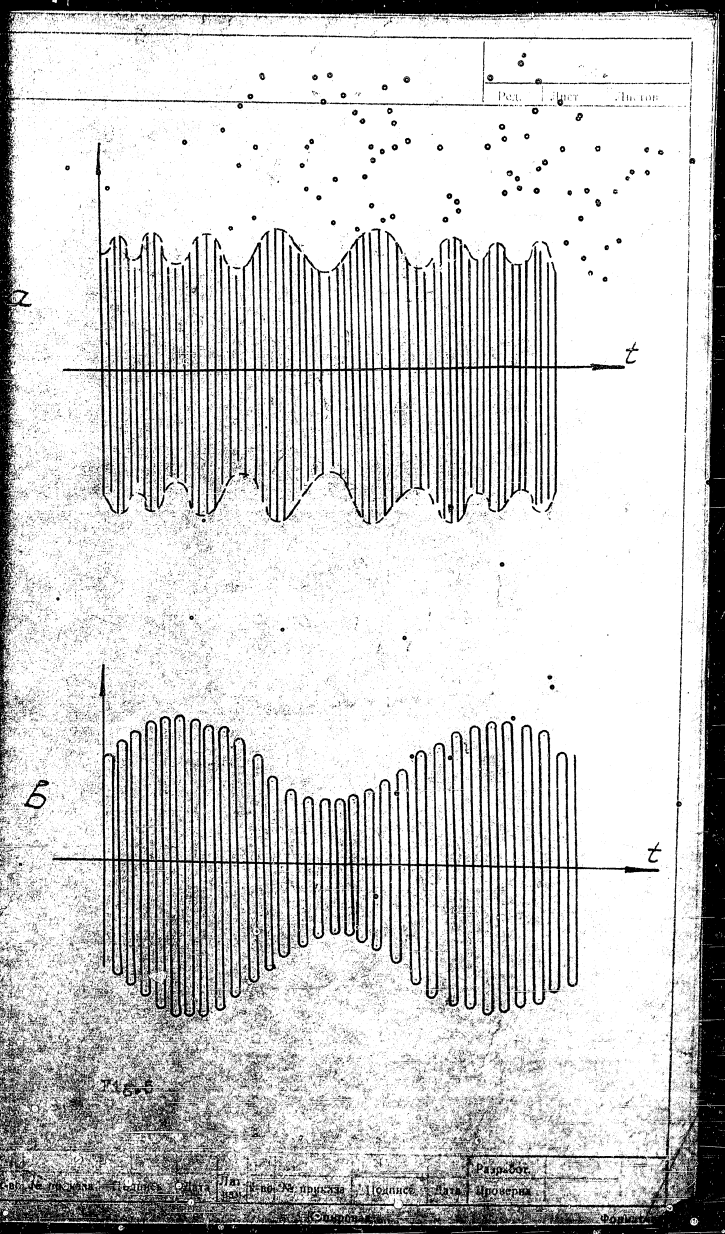

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[illegible] of the peculiarities of the received signal, the [illegible] receiver includes frequency-discriminator and limiter [illegible], [illegible] characteristic of frequency modulation receiver. [illegible] amplifier section contains two channels: a constant-phase voltage amplifier channel and a variable-phase voltage amplifier channel.

When the aircraft is exactly on the course line, the receiving antenna of the course receiver receives only the constant-phase radiation. In this case the pointer of the course indicator is in the middle (zero) position.

When the aircraft deflects from the course line in one or the other direction, the antenna also receives the variable-phase radiation. Depending on which side of the course line the aircraft has deflected to, the 50-c/s modulating voltages of both radiations will either coincide in phase or be in anti-phase.

Comparison of the phases of these voltages in a special phase-comparing device determines the deflection of the course indicator pointer. The pointer deflects in that direction where the course line is and shows which way to steer the aircraft, in order to bring it on the course line (see Fig.68).

When operating in the "ILS" system, the course beacon radiates an amplitude-modulated (AM) signal. In this case the directivity pattern of the course beacon antenna consists of two lobes which are narrow in the horizontal plane. The equisignal zone formed by the radiation lobes corresponds exactly to the course line. To the right of the equisignal zone the field modulated by a voltage having frequency of 150 c/s predominates and to the left that modulated by a voltage having a frequency of 90 c/s. Depending on the position of the aircraft with respect to the course line, a signal having a modulation frequency of 90 or 150 c/s will predominate in the receiver.

The presence in the "ILS" system of an AM signal different from that of the signal in the "СП-50" system, makes possible

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the use, in the audio frequency section of the "П-ф" of only one stage of the variable-phase channel, from the output of which the amplified audio-frequency signals are applied to the amplitude attachment, type АП.

The type АП amplitude attachment is an addition to the "ОП-50" system aircraft equipment and is designed for ensuring landing of aircraft according to the signals of the course and glide-slope radio beacons of the international "ILS" blind landing system.

The АП channel provides further amplification of the 90 and 150 c/s signals, their separation and rectification. The d.c. components obtained as a result of rectification, are applied to the "ПОП-48" course indicator. Predominance of one of the components causes the pointer of the course indicator to deflect and signals the flyer that the aircraft has deflected from the equisignal zone of the course beacon. When flying the landing course to the beacon, the vertical pointer of the course indicator deflects in the opposite direction to that of the aircraft, i.e. when the aircraft deflects to the right the pointer deflects to the left, and when the aircraft deflects to the left, the pointer deflects to the right. Should the aircraft be flying in the opposite direction to the landing course, the vertical pointer of the indicator will deflect in the same direction, i.e when the aircraft deflects to the right, the pointer deflects to the right and when the aircraft deflects to the left, the pointer deflects to the left.

In other words, when flying the landing course, the pointer indicates which way to turn the aircraft to enter the zone.

When flying in the opposite direction to the landing course, the pointer indicates in which direction the aircraft had deflected from the zone.

If the aircraft is located to the left of the course zone and turns round through 360°, without crossing the zone, the

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ndicator pointer will deflect all the time in one direction. the aircraft is located to the right of the course zone, with t crossing the zone, then regardless of the position of the ircraft, the indicator pointer will continue to deflect in the pposite direction.

When the aircraft is flying along the course zone, the rtical pointer of the indicator stops at the zero position, dicating the landing course to the pilot. However, as the ergency window is shut by a black flap, this is an indication at the transmitting-receiving channel is in order.

It follows from the above, that the method of steering an ircraft for landing with the aid of the "ILS" system, when using e ГРП-2 and КРП-ф receivers together with the amplitude attach nt does not differ from that of the "СП-50" system.

The КРП-ф receiver operates from a combined antenna, which s mounted outside on the aircraft body, or from a slot antenna ich is installed in the aircraft body.

In order to increase the inertia of the course and glide-lope indicator pointers in both the "СП-50" and "ILS" systems, e is made of a capacitors unit.

The КРП-ф and ГРП-2 receivers are supplied from the ircraft network of 27 volts D.C. The current consumed from the etwork does not exceed 3 amperes for each radio receiver. The upply voltage of the КРП-ф and ГРП-2 is switched on with the aid f the toggle switch "БКЛ" ("ОХ") located on the control panel. e valve heaters of the ГРП-2 and КРП-ф receivers are supplied rectly from the aircraft network. The receivers are supplied th high voltage from a dynamotor, type У-18-1.

The circuit diagram, specifications, and wiring diagram f the ГРП-2 are given in appendices Nos.1, 6 and 7, respectively.

The circuit diagram, specifications, and wiring diagram f the КРП-П are given in appendices Nos.8,5 and 9, respectively.

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The circuit diagrams and specifications of the amplitude attachment and the circuit diagram and specifications of the capacitors unit are given in appendices Nos. 3,4,10, and 11, respectively.

II. OPERATION PRINCIPLE

[illegible] OF THE ГРП-2 RADIO RECEIVER

The block diagram of the ГРП-2 radio receiver is shown in Fig.6

The signal received by the antenna of the radio receiver is applied to the input circuit which is designed for operation with a 75-ohm feeder and consists of two coaxial tuned circuits which form a bandpass filter with a bandwidth which ensures passage of all three working frequencies.

The selectivity of the input filter is sufficient for a 100-fold attenuation of the image channel which lies below the frequency of the received signal.

In addition to providing the required input passband and image frequency rejection, the input circuit serves for matching the characteristic impedance of the feeder to the input impedance of the mixer valve. The mixer (frequency converter) employs a 6Ж1П valve in a single-grid conversion circuit. The control grid of the mixer stage is supplied with the voltage of the input signal and the voltage of the local oscillator, which is lower in frequency than the signal. The anode circuit of the mixer includes a bandpass filter which separates out the intermediate-frequency signal.

The close spacing of the fixed frequencies of the radio receiver requires the use of an intermediate frequency amplifier with a sufficiently narrow passband (for good de-tuning from the adjacent channel). The use of a narrow-band intermediate frequency amplifier is possible only if the frequency of the local oscillator is highly stable. Therefore the frequency of the local oscillator is crystal-controlled. The local oscillator consists of a crystal-controlled master oscillator and five stages of frequency multiplication.

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The master oscillator employs the right-hand triode of a 6N1P valve. Its anode circuit includes a circuit tuned to the crystal frequency; one of the three crystals which determine the fixed frequencies of the oscillator can be connected to the grid circuit. Feedback is provided by the grid-anode capacitance of the valve. The crystals are switched from the control panel with the aid of three two-winding high-frequency relays. One winding of one of the relays corresponds to each position of the frequency switch. This makes possible simultaneous switching of three crystals of the glide-slope and six crystals of the course radio receivers (the course receiver has six crystals which are switched with the aid of six single-winding relays).

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The passband of the master oscillator anode tuned circuit and of all the multiplier tuned circuits are selected such that the three working frequencies would lie within the passband. Thus the local oscillator frequency is changed without retuning the tuned circuits, switching of the crystals being sufficient for changing the frequency. The crystal frequency is multiplied by the five frequency multiplication stages 48 times. The first stage, a doubler, is incorporated with the master oscillator. The anode circuit of the master oscillator includes two tuned circuits. The first, tuned to the crystal frequency, is included in the master oscillator circuit, the second, tuned to the second harmonic of the crystal frequency, is included in the frequency doubler circuit. Voltage of the second harmonic of the crystal frequency is applied to the next stage, (a tripler) which separates out the sixth harmonic. Next, the following doubler stages separate out the 12th, 24th and 48th harmonics of the crystal frequency. The 12th and 24th harmonics are separated out by ordinary tuned circuits with lumped constants; the 48th harmonic is separated out with the aid of a coaxial tuned circuit. From the coaxial circuit, voltage of the 48th harmonic is applied to the mixer grid via a blocking capacitor.

The intermediate frequency amplifier consists of three r.f. amplifier stages employing 6Ж1П valves.

The ГРП-2 receiver uses a high intermediate frequency. The choice of such a high frequency is due to the need of good rejection of the image frequency.

The ГРП-2 receiver employs a fairly broad-band input circuit which passes all the working frequencies without retuning. For good rejection, the image channel of such a receiver must be removed considerably from the main channel, i.e. the intermediate frequency must be sufficiently high.

The two-circuit intermediate frequency filters, which have external capacitive coupling, provide the necessary passband of the receiver and good adjacent-channel selectivity.

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The gain of one intermediate frequency stage is of the order of 15.

The detector and the automatic gain control rectifier (A.G.C.) employ a 6Х1П valve. The detector employs an ordinary circuit. The automatic gain control rectifier employs a delayed circuit. At weak signals the A.G.C. does not operate. Negative voltage from the A.G.C. rectifier is applied to the control grids of all the intermediate frequency amplifier stages. The A.G.C. characteristic of the receiver allows a current within 150-1000 μA to be maintained in the indicator with variation of the input signal from 500 to 100,000 MV.

The two-stage audio-frequency amplifier employs a 6Н1П double triode. The second audio frequency amplifier stage is loaded by filters of 90 and 150 c/s connected in parallel. Connected to the filter outputs are copper-oxide rectifiers in a bridge circuit which produce the opposing currents in the indicator winding and the current in the emergency signalizer winding. The operation of the output circuit of the receiver can be seen from the block diagram (Fig.7).

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Fig.7. 1. Audio frequency amplifier output 2.20-c/s filter 3.Copper-oxide bridge
4. Rectifier winding 5. Indicator winding 6.150 c/s filter 7.Copper-oxide bridge.

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From the amplifier outputs, the signal, containing frequencies 90 and 150 c/s, is applied to the input of the 90 and 150 c/s filters. These frequencies are divided into two channels in the filters. Each channel is provided with its own bridge-type copper-oxide rectifier. Each rectifier has an independent load circuit. A load circuit of one rectifier is shown in Fig.8.

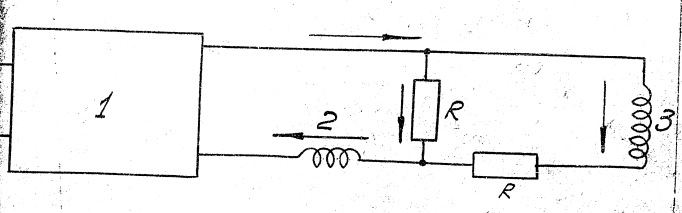

Fig.8.
1. Copper-oxide bridge. 2, Emergency signalizer winding.
3. Glide-slope indicator winding.

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The rectified current passes through the winding of the radio-slope indicator and the winding of the emergency signaliser, as shown in Fig. by arrows. Fig.7 shows the connection of the windings of both rectifiers (the arrows show the directions of the rectified currents). The rectifiers are connected so that opposing currents flow through the indicator winding. The local circuit of each rectifier are completed through the emergency signaliser winding. The currents of both rectifiers coincide in direction in this winding. Thus the emergency signaliser operates both when one signal is present and when both signals are present and when they are equal.

The value and direction of the current flowing through the indicator winding is determined by the magnitude of the relation between the 90 and 150 c/s signals.

The sensitivity of the receiver is not worse than 250 MV when operating with one ПСП -48 indicator and not worse than 200 MV when operating with two ПСП -48 indicators.

BLOCK DIAGRAM OF THE РСП-6 RADIO RECEIVER

The block diagram of the РСП-6 receiver is shown in Fig.8.

The receiver antenna receives the ultra-high frequency signals of the constant- and variable-phase radiations, when the aircraft is on the course line. With the aid of a two-conductor high frequency cable, these signals are fed from the antenna to the receiver input.

The input circuit and the bandpass filter of the radio frequency amplifier stage ensure passage of the whole band of frequencies corresponding to the six fixed waves. As a result, when crossing from one fixed frequency to another, no switching of the input stage circuits is required.

Switching from one fixed frequency to another is obtained by varying the local oscillator frequency. The local oscillator frequency is crystal controlled and can be changed by connecting

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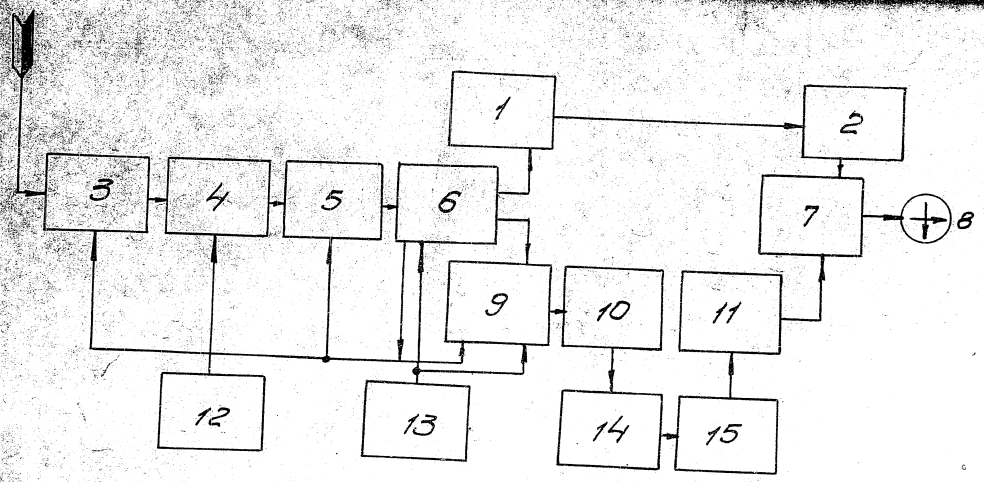

Fig.9

1.60 c/s pre-amplifier 6Н2П 2. Variable phase output amplifier 6Н3П 3.Radio frequency amplifer 6Ж1П 4.Mixer 6Ж1П 5.Intermediate frequency amplifier 6Ж4П 6.Second detector and A.G.C. rectifier 6Ж2П 7.Phase detector 6Н3П 8.ПСП-48 indicator 9.10 Kc/s and A.G.C. amplifier 6Н2П 10.Kc/s amplifier 6Н2П 11.Constant-phase output amplifier 6Н3П 12.Local oscillator 6Н3П , 6Ж1П 13.Bias and A.G.C.generator 6Н3П 14.Limiter 6Н2П 15.Discriminator 6Н2П

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one or another crystal to the grid circuit of the master oscillator with the aid of a switch located on the control panel.

The radio receiver employs delayed automatic gain control (A.G.C.) For its operation, the A.G.C. system of the receiver requires a constant negative voltage of the order of 100 volts. To obtain this voltage without consuming the anode voltage produced by the dynamotor, use is made of a special high frequency generator and rectifier (bias voltage generator employing a 6Н3П valve V_{13}).

radio frequency amplifier stage is included in the receiver with the view of obtaining good image frequency rejection and a good signal-to-noise radio, which is of great significance for such high-sensitivity receivers, as the course receiver.

The signal, amplifided by the R.F. amplifier, is applied to the grid of the mixer which also employs a 6Ж1П valve (V_2). The mixer employs a single-grid conversion circuit.

The control grid of the mixer valve is also supplied with a signal from the local oscillator. The local oscillator, the frequency of which is crystal controlled, contains a master oscillator and three frequency multiplication stages, employing 6Н3П and 6Ж1П valves (V_{11}, V_{12}).

The left-hand triode of the 6Н3П valve (V_{11}) operates as a crystal-controlled master oscillator and a frequency tripler (the crystal is connected in the grid circuit and feedback is provided by the grid-anode capacitance). The third harmonic of the crystal frequency is developed in the anode circuit of this triode.

The right-hand triode of the 6Н3П valve (V_{11}) operates as a second tripler, i.e. the anode circuit separates out the 9th harmonic of the crystal frequency. The stage employing the 6Ж1П valve (V_{12}) operates as a frequency doubler. The 18th harmonic which is developed in its anode circuit is applied to the mixer.

The mixer stage converts the received-frequency signal into the intermediate frequency which is selected such as to obtain

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good image channel rejection and sufficient amplification in the intermediate frequency stages. The intermediate frequency amplifier has two stages employing 6Ж4П valves (V_3, V_4).

The intermediate frequency signal, amplified to a voltage of the order of 0.5 volts, is applied to the anode of the detector diode (valve 6Ж2П V_5). Two voltages are developed across the detector load: a voltage of 60 c/s from the variablephase signal and a voltage of 10 Kc/s frequency modulated by a frequency of 60 c/s from the constant-phase signal.

The frequency modulated voltage of 10 Kc/s is applied via a filter circuit to the grid of the first amplifier of the constant-phase channel (triode of the valve 6Ж2П V_6). The RC filter circuit serves for separating the modulating voltages of the variable-and constant-phase signals, which are developed across the load of the second detector. From the anode load of the first constant-phase amplifier, the 10-Kc/s voltage (which is frequency modulated) is applied to the next amplifier which is simultaneously a limiter and employs the left-hand triode of the valve 6Ж2П (V_6). The amplified voltage is applied to the control grid of the right-hand triode of the 6Ж2П valve (V_6), the limiter stage.

The limiter serves for eliminating parasitic amplitude modulation of the 10-Kc/s signal which is frequency modulated. The load of the second limiter stage is a tuned circuit included in the discriminator circuit. The discriminator converts the frequency-modulated signal into the initial 60 c/s modulating voltage. The discriminator stage employs a 6Ж2П valve (V_7). The 60-c/s voltage developed across the load of the discriminator is applied [illegible] amplifier.

The amplifier employs the left-hand triode of the 6Ж2П valve (V_{10}). The load of the stage output is the RC circuit included in the phase detector circuit.

The 60-c/s voltage developed across the load of the second detector on detecting the variable-phase signal is applied to the [illegible]

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tage of this amplifier employs the right-hand triode of the valve 6Н2П (V_8), the output stage employs the right-hand triode of the 6Н2П valve (V_9). The load of the phase output is the transformer Tr_1 included in the phase detector circuit and called the variable-phase transformer.

The grid circuit of the output stage of the variable-phase channel includes a potentiometer which controls the gain of the variable-phase channel.

The phase detector employs a 6Н2П valve (V_{10}). The secondary winding of the variable-phase transformer is connected between the grids of the double triode. The load of the constant-phase amplifier is connected between the centre-tap of this winding and the rectifier anodes.

When a signal appears in the variable-phase channel (i.e. when the aircraft has deflected from the course line), an increase in the a.c. voltage at one grid with a corresponding decrease at that at the other grid. The anode currents of the triodes become unequal, causing the pointer of the course indicator which is connected in parallel with the anode load, to deflect.

In parallel with the resistor in the cathode circuit is connected the winding of the emergency signaliser, which operates when a signal arrives from the constant-phase channel at the grid of the phase detector.

The sensitivity of the receiver is not worse than 50 mV.

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PRINCIPLE OF OPERATION AND CONSTRUCTIONAL FEATURES OF THE TYPE АП AMPLITUDE ATTACHMENT

The block diagram of the amplitude attachment is shown in Fig. 10.

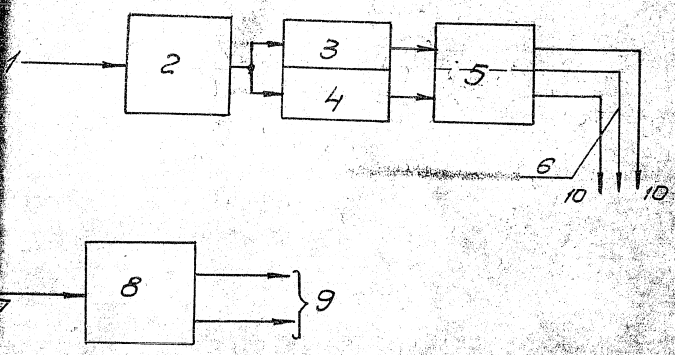

Fig.10.
1.From КПП-6 2.Audio frequency amplifier 3.90 c/s filter 4.150 c/s filter 5.Rectifier 6.Signalizer current 7.From ПРП-2 8.Relay 9.To glide-slope indicator pointer 10. To course indicator pointer.

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The amplitude attachment is made in the shape of a separate audio-frequency amplifier unit with two filters for frequencies of 90 and 150 c/s and two copper-oxide rectifiers.

The d.c. components obtained as the result of rectification of the 90 and 150 c/s voltages are applied to the ПСП-48 course indicator, i.e. the circuit of the amplitude attachment is similar to the audio frequency section of the РПП-2 receiver.

The amplitude attachment is switched on by remote control by means of the switch "СП-50-ПРС" ("СП-50-ИЛС") located on the М-50 control panel or in the immediate vicinity of the pilot.

When operating in the "СП-50" system, the amplitude attachment is de-energized. In the "СП-50" system, the d.c. components of the output currents of the receivers КРП-2 and РПП-2 are fed via the normally closed contacts of the relays P_1, P_2, P_3, located in the amplitude attachment (see appendix No. 10), to the indicator pointer winding and the emergency shutter winding of the course section of the ПСП-48 instrument and to the indicator pointer winding of the glide-slope section of the ПСП-48 indicator, respectively. The winding of the emergency shutter of the glide-slope section of the ПСП-48 instrument, both in the "СП-50" system and the ИЛС system is supplied with a d.c. component directly from the АВК-1 rectifier of the РПП-2 receiver, bypassing the amplitude attachment.

When operating in the ИЛС system, the switch "СП-50-ПРС" ("СП-50-ИЛС") is set in the position "ПРС", in this case the amplitude attachment is supplied with a d.c. voltage of +27 V, as a result of which the lower circuits are supplied and the relays P_1, P_2 and P_3 operate. Anode voltage is supplied to the amplitude attachment by means of the switch "ВКЛ" ("ON") located on the control panel.

Audio-frequency oscillations of 90 c/s having an amplitude of 4 to 10 volts are taken from the resistor R_{44} in the КРП-2 receiver and with the aid of the coils P_1 are applied to the input of the valve V_1 of the amplitude attachment.

The valve V_1 (6Ж5П) operates in the linear section of its characteristic. In order to provide a negative bias for the

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circuit of the valve includes the resistor R_3 of 1,000 ohms and a capacitor C_2 of 50 mF. The anode load of the valve is the choke Ch_1 and the 90 and 150 c/s filters.

The amplified voltages of 90 and 150 c/s are fed via the coupling capacitor C_3 to the 90 and 150 c/s filters.

The frequency responses of the filters (Fig. 11) are similar such as to pass a narrow band of frequencies close to 90 and 150 c/s and to greatly attenuate all other frequencies.

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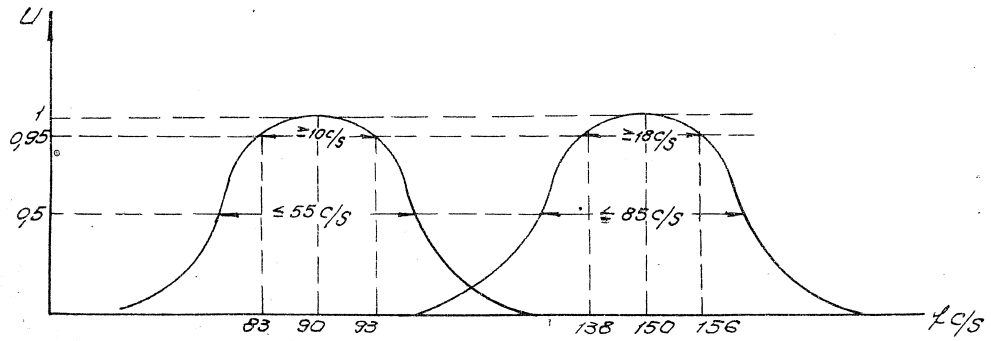

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The amplified 90 and 150 c/s components are converted into d.c. components by a copper-oxide rectifier, type АВК-11, and are fed with the aid of the relays P_1, P_2 to the indicator and shutter windings of the course section of the ИСН-48 instrument. When the relay P_3 operates, the polarity of the voltage supplying the glide-slope section of the ИСН-48 instrument changes. The resistors R_4, R5, R_6 are included in the electrical "0" balancing circuit, the resistors R_7, R_{11} are included in the charge and discharge circuits of the capacitor C_3, installed in the capacitors unit.

The jack J_1 is provided for checking the audio frequency of the КРП-4 receiver from an "ИЛС" ("ILS") imitator. For increasing the inertia of the pointers of the course and glide-slope indicators, the capacitors C_1 and C_2 of 1000 mF and 500 mF, respectively, are connected, which are located in the capacitors unit.

The amplitude unit is made in the shape of a separate unit assembled on a chassis which is inserted into a casing mounted on a shock-absorber frame.

Shock-absorption is provided by six shock-absorbers, type "271-С-49-1-2".

The chassis is secured to the casing by means of 4 captive screws, two of which are located at the top of the front panel of the unit, and two at the bottom of the rear wall of the casing. The casing is provided with louvers in the side walls and top, which ensures sufficient cooling of the equipment during operation.

In the lower left-hand corner of the front panel there is mounted a connector plug, type ШР32П14НШ5. Higher, above the connector, are located the slotted shafts of the potentiometers "БАЛАНС. К-ИЛС" ("BALANCE K-ILS" and "ЧУВСТВ. К-ИЛС" ("SENSITIVITY K-ILS").

An earthing binding post is located at the lower right-hand corner of the front panel of the unit. A jack marked "КОНТРОЛЬ 0" ("ZERO CHECKING") is located at the upper right-hand corner of the front panel. On top of the horizontal part of the chassis are mounted the relays P_1, P_2, P_3, type [illegible]

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alve 6Н3П, the capacitor C_2 of 50 mF, an anode choke and the ropping resistor included in the heater circuit of the valve. his resistor is provided with a special heat screen. The ype АВК-11 copper-oxide rectifier is secured under the chassis. bracket is secured to the rear of the chassis, on which are ounted the 90 and 150 c/s filters and the blocking capacitor f 0.5 mF.

All the wiring is made with МГШВ 0.35 mm² wire and is ocated under the chassis. The amplitude attachment is shown n Figs. 12, 13 and 14.

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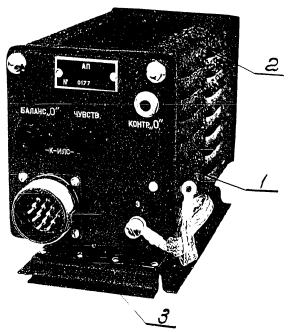

Fig.12. Amplitude attachment. General view

1. Front panel; 2 - Casing; 3 - Shock absorber frame

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Fig.13. Amplitude attachment with casing removed.

1 - Chassis; 2 - 90c/s filter; 3 - 150c/s filter; 4 - Propping resistor in valve heater circuit; 5 - Heat shield; 6 - Variable resistor; 7 - Jack; 8 - P30-6 relays; 9 - 6H8M valve; 10 - Resistor 50 mF.

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Fig.14. View from circuitry side

1 - Blocking capacitor; 2 - Copper-oxide rectifier;
3 - "Earth" binding post; 4 - Anode choke; 5 - Connector

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Fig.15. Capacitors unit. General view

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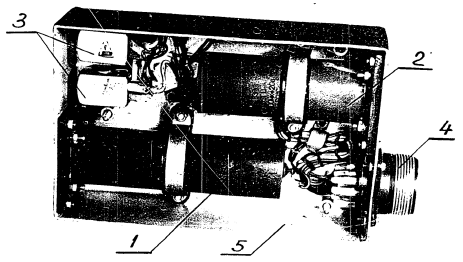

Fig.16. Capacitors unit with lid removed.
1 - Capacitor, 1000 mF; 2 - Capacitor, 500 mF; 3 - Relay, type
4 - Connector [illegible]; 5 - Casing

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[illegible]

[illegible]

[illegible]

[illegible] of the input circuit and the [illegible] is shown [illegible]

[illegible] consists of two coaxial tuned circuits [illegible] a bandpass filter. The coaxial tuned circuits [illegible] electrical circuits with distributed constants.

[illegible] circuits is explained by the fact that ultra-high-frequency [illegible] circuits have to possess very low inductances [illegible] capacitances.

[illegible] a section of a conductor arranged in parallel [illegible] surface (Fig. 18, a). This section possesses a certain [illegible] inductance and a certain very low capacitance with respect to earth. The values of these inductances and capacitances are of the same order of values required for [illegible] ultra-high-frequency circuits to resonance.

[illegible] straight conductor can be regarded as [illegible] inductance. It is also necessary to consider the capacitance [illegible] conductor with respect to neighbouring conductors and earth. The inductance of the conductor (Fig. 18, a) can be regarded as the sum of the series-connected inductances of very small sections of this conductor (Fig. 18, b). Each point of the conductor (Fig. 18, a) has a certain capacitance with respect to earth. The capacitance of small separate sections of the conductor, with respect to earth, can be considered (Fig. 18, c). All in all the conductor (Fig. 18, a) will thus have the equivalent circuit shown in Fig. 18, d. Electrical circuits [illegible] inductance and capacitance, distributed along the conductor, must be taken into account, similar to the circuits shown in Fig. 18, are known as circuits with distributed constants.

The coaxial tuned circuit consists of two brass tubes, soldered to a brass bottom and having a common axis (Fig. 19, a).

The outer tube is well earthed. It is provided with holes for outlets, with the aid of which the inner thin-walled tube is connected to the circuit. At the bottom end, the circuit is

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[illegible]

[illegible]

[illegible]

[illegible] of the input circuit and the mixer is shown in [illegible].

[illegible] consists of the coaxial tuned circuits [illegible] and [illegible] a bandpass filter. The coaxial tuned circuits belong to electrical circuits with distributed constants.

The use of such circuits is explained by the fact that ultra-high-frequency tuned circuits have to possess very low inductances [illegible] capacitances.

[illegible] a section of a conductor arranged in parallel [illegible] surface (Fig. 18, a). This section possesses a certain very low inductance and a certain very low capacitance with respect to earth. The values of these inductances and capacitances are of the same order of values required for tuning ultra-high-frequency circuits to resonance.

[illegible] straight conductor can be regarded as [illegible] inductance. It is also necessary to consider the capacitance of this conductor with respect to neighbouring conductors and earth. The inductance of the conductor (Fig. 18, a) can be regarded as the sum of the series-connected inductances of very small sections of this conductor (Fig. 18, b). Each point of the conductor (Fig. 18, a) has a certain capacitance with respect to earth. The capacitance of small separate sections of the conductor, with respect to earth can be considered (Fig. 18, c). All in all the conductor (Fig. 18, a) will thus have the equivalent circuit shown in Fig. 18, d. Electrical circuits in which inductance and capacitance, distributed along the conductor, must be taken into account, similar to the circuits shown in Fig. 18, are known as circuits with distributed constants.

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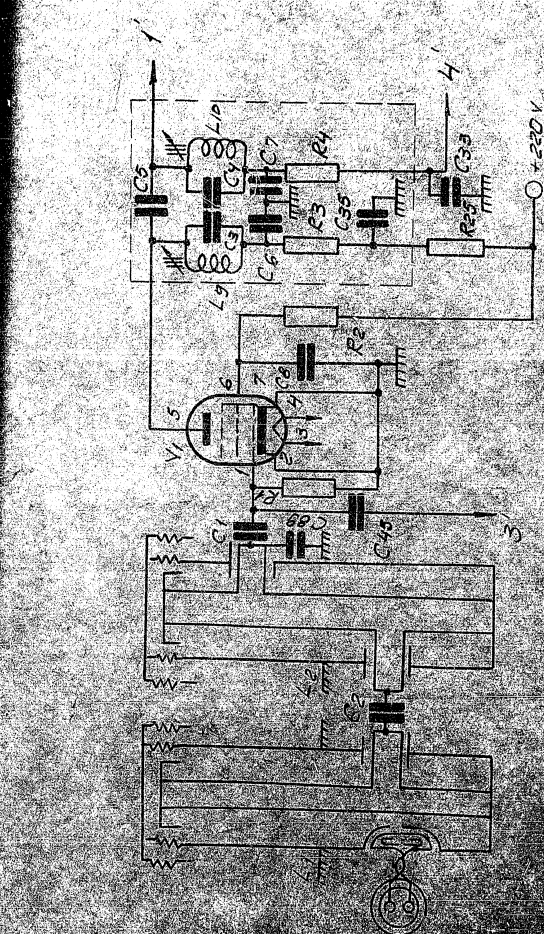

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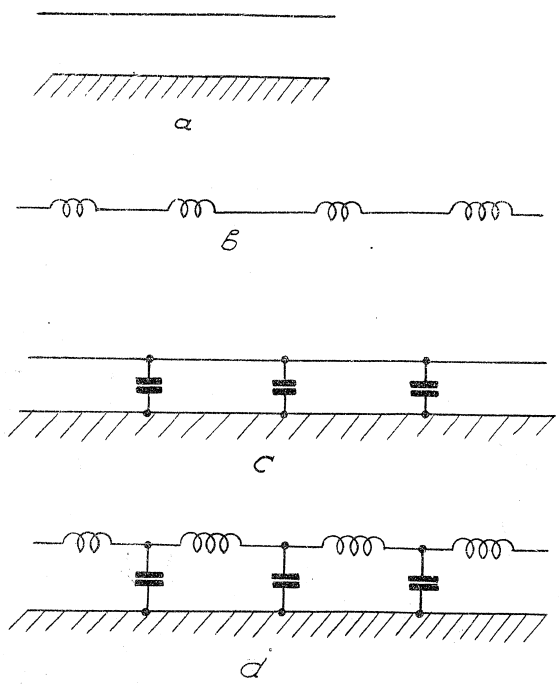

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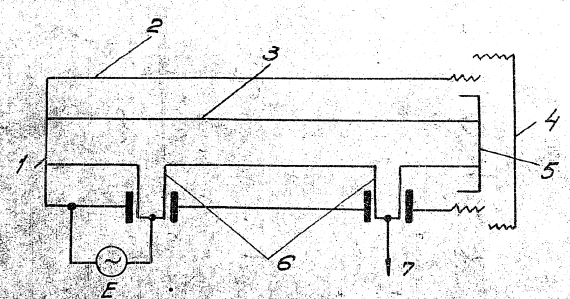

Fig.19a

2. Outer tube, 3. Inner tube 4. Screw-on lid 5. Cup forming additional space with lid 6. Outlets for connection to circuit components. 7. To load

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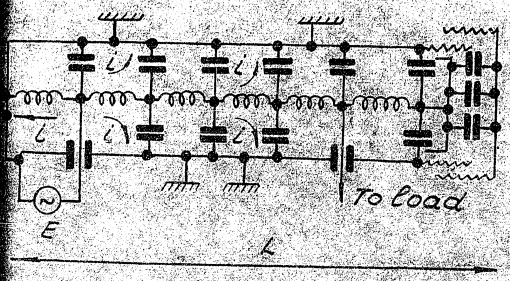
B



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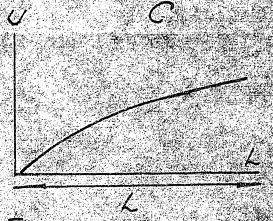

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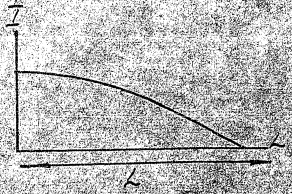

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rt-circuited, and at the lid end, linked by a capacitance
between the cup which is fitted on the inner tube
. The value of the capacitance can be varied by screwing
lid on and off. The operation of the coaxial circuit is
plained by the Fig. 19, b. The outer tube of the circuit is
thed and under zero potential. The inner tube possesses
tributed capacitance with respect to the outer tube (earth).
distribution of the inductance and capacitance is shown in
. 19, b (similar to that shown in Fig. 18).

If an r.f. e.m.f. is applied to part of the circuit, radio
quency currents will flow through the circuit. These cur-
nts are shorted to the outer tube either directly through the
er tube, or through the distributed capacitance. As the
uctance and capacitance of the coaxial circuit are distri-
ted along its length, the ultra-high-frequency currents and
tages in the circuit are also distributed along the the
gth of the circuit. The highest current between the inner
outer tubes flows at the places of most coupling between
ese tubes, i.e. at the bottom where the inner and the outer
bes are short-circuited. The voltage at this point is equal
zero.

Moving along the coaxial circuit from the bottom towards
e lid, the value of the high-frequency current gradually de-
reases, and the amplitude value of the voltage increases from
int to point. The amplitude of the radio frequency voltage
current is different at various points of the circuit, but
nstant for each given point (Fig. 19, c).

The law of distribution of the currents and voltages
long the circuit can be varied by adjusting one of the circuit
rameters (inductance or capacitance). In the coaxial circuit
nder consideration, the capacitance between the cup on the end
the inner tube and the screw-mounted lid is adjusted. When
ning the circuit to a definite frequency, the highest voltage
this frequency across the load is obtained by turning the
d. The load is connected near the open end of the circuit
ear the lid). The receiver antenna is inductively coupled
the coaxial circuit L_1 (Fig. 17) by means of a coupling loop.

The coaxial circuits (L_1 and L_2) form a bandpass filter.

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The capacitance C_5 is selected from the outlet of the coaxial circuit L_1 to earth screen for shortening the electrical length of the coaxial circuit and, consequently, for decreasing the value of the shifting capacitance and increasing the frequency stability of the circuit.

The two circuits are capacitively coupled. Voltage for circuit L_2 is taken from part of circuit L_1 via the coupling capacitor C_2. The signal voltage from the circuit L_2 is applied via the blocking capacitor C_1 to the mixer grid (first pin of valve V_1). The same grid is supplied via the capacitor C_{45} with the voltage of the 40th harmonic of the local oscillator. The operating conditions of the mixer valve are selected such that the working point lies in the nonlinear section of the valve characteristic. The voltages supplied to the anode and screen grid of the mixer are low and almost equal. Bias is produced for the control grid with the aid of the circuit $R_1 - C_{45}$, at the expense of the grid currents produced by the 40th harmonic of the local oscillator. The anode circuit of the valve includes the first intermediate frequency filter which separates out the intermediate frequency from the mixer signal. The first filter consists of two intermediate frequency tuned circuits $L_9 - C_3$ and $L_{10} - C_2$, the coupling capacitor C_5 and the components of the decoupling circuits R_3, R_4, C_6, C_7, R_{25}, C_{35}. The resistor R_2 and the capacitor C_8 are components of the screen-grid decoupling circuit.

Local oscillator

The master oscillator and the five frequency multiplication stages of the local oscillator employ only three valves V_9, V_8 and V_7, which are 6НП, 6Н3П and 6НП , respectively.

The master oscillator operates with one of three crystals. A simplified circuit diagram of it for the fundamental crystal frequency is shown in Fig. 21. The grid circuit includes the crystal. In the anode circuit, the load for the fundamental crystal frequency is the circuit $L_8 - C_{59}$ tuned to the crystal frequency. The impedance of the circuit $L_7 - C_{60}$ (Fig. 20)

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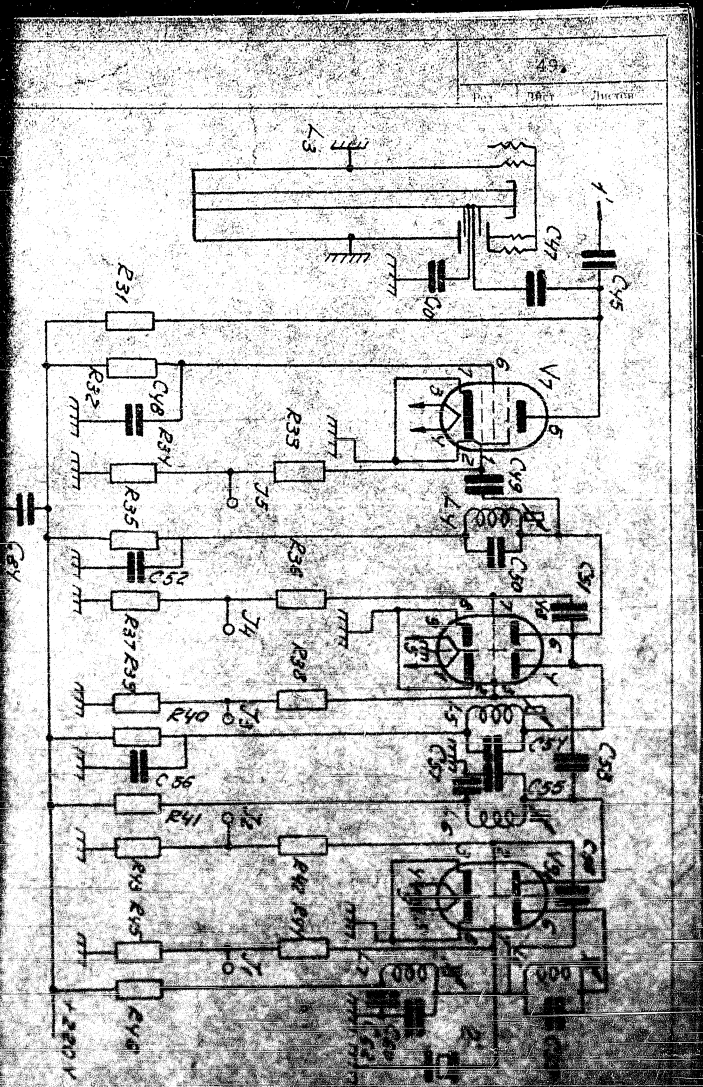

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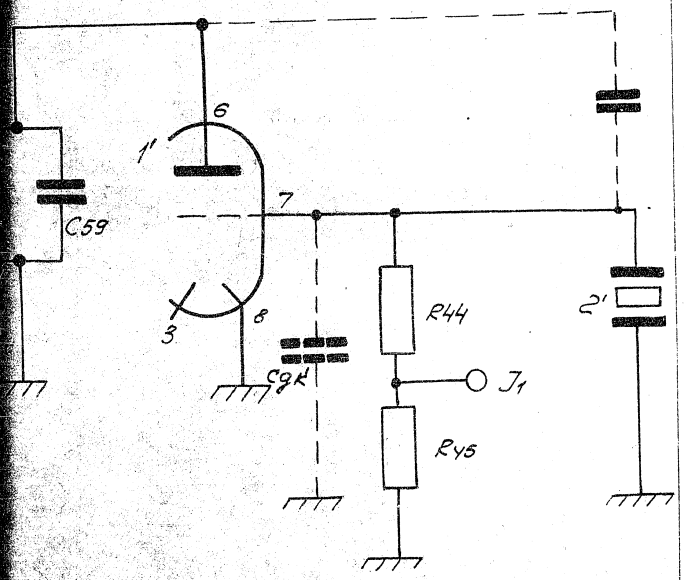

Fig. 21

1 - V_9 2. C_{x_1}

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which is tuned to the second harmonic of the crystal frequency [illegible] delivery [illegible] frequencies [illegible] can be disregarded. [illegible] frequency currents are short-circuited to earth via the capacitor [illegible]. Therefore, considering the circuit from the point of view of audio frequencies, one end of the circuit [illegible] is earthed (Fig. 21).

[illegible], in the crystal oscillator, the anode and grid circuits are in the tuned circuit L_8 – C_{59} and the crystal (in the latter case the crystal possesses inductive reactance). Feedback [illegible] the grid-anode capacitance of the valve.

[illegible] bias is developed by the voltage drop caused by the grid current flowing through the resistors R_{44}, R_{45} and the [illegible] across the grid-cathode capacitance of the valve. In series with the third harmonic circuit L_8 – C_{59}, the anode circuit of the crystal oscillator also includes the circuit L_7 – C_{57} tuned to the second harmonic of the crystal. The second harmonic of the valve anode current is developed across this circuit, and is used for multiplication in the subsequent stages of the local oscillator.

Voltage of the second crystal harmonic is developed across the circuit L_7 – C_{50} and applied via the blocking capacitor [illegible] to the grid of the second triode of the valve V_9, which operates as a frequency tripler; across the anode circuit of the tripler, the sixth harmonic of the crystal frequency is developed. In the frequency doubler stages employing the valve [illegible] developed the 12th and 24th harmonics of the crystal frequency. Voltages of the 6th, 12th and 24th harmonics are developed across the tuned circuits L_6—C_{55}, L_5—C_{54} and L_4—C_{50}, respectively. Coupling to the following stages is provided via the blocking capacitors C_{53}, C_{55}, C_{51} and C_{49}. Bias for the control grids is obtained by the voltage drops caused by the grid currents across the resistors R_{42}, R_{43}, R_{38}, R_{39}, R_{36}, R_{37}, R_{35} and R_{34}.

The frequency multiplication stages are tuned to maximum grid currents. For measuring the grid currents, the jacks I_1, I_2, J_5, I_4 and I_5 are provided, to which a microammeter is connected.

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The anode circuit of the last frequency multiplication includes a coaxial tuned circuit across which the 48th nic of the crystal frequency is developed. The coaxial circuit of the 48th harmonic is similar to the coaxial circuits L_1 and L_2 considered above. From the anode of valve V_7, the signal of the 48th harmonic is applied via itor C_{45} to the mixer grid. In addition to the components loned above, the local oscillator circuit includes decoupling nents of the anode circuits R_{46}, R_{41}, R_{40}, R_{35}, C_{62}, C_{57}, C_{52}, C_{84}. If the need arises, the resistor R_{24} is in- ed in the anode circuit of the 24th-harmonic multiplier stabilizing the operation of the local oscillator. The e of the valve V_7 is parallel fed. The capacitor C_{47} is a king capacitor. The screen grid circuit of the valve V_7 udes the decoupling filter R_{32}, C_{48}.

The local oscillator crystals are switched from the control l with the aid of high-frequency double-winding relays . 22). The highfrequency relays differ from ordinary ys in their small size and the design of the contact system h ensures the introduction of a low capacitance, allowing relays to be connected in radio frequency circuits. The -winding relays used in the radio receiver operate when est current passes through either one of the two windings.

The crystal switching circuit is shown in Fig. 23. As n from the diagramm (Fig. 23), the current circuit is made only one of the six relay windings, depending on the posi- n of the switch. Each course relay of the radio receiver connected via a distribution box in parallel with one of relay windings of the glide-slope receiver. Thus, the quency switch makes it possible to select simultaneously of the six frequencies of the course receiver and one of three frequencies of the glide-slope receiver. The switch itions for the various frequencies of the course and glide- pe receivers were given above. The resistor $R_{[illegible]}$ serves dropping the voltage applied to the relay. The relay ing has a resistance of [illegible] ohms. The operating current is

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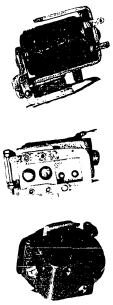

Разработ.

Проверил

№ приказа | Подпись | Дата | Лит. | к-во | № приказа | Подпись | Дата

Копировал

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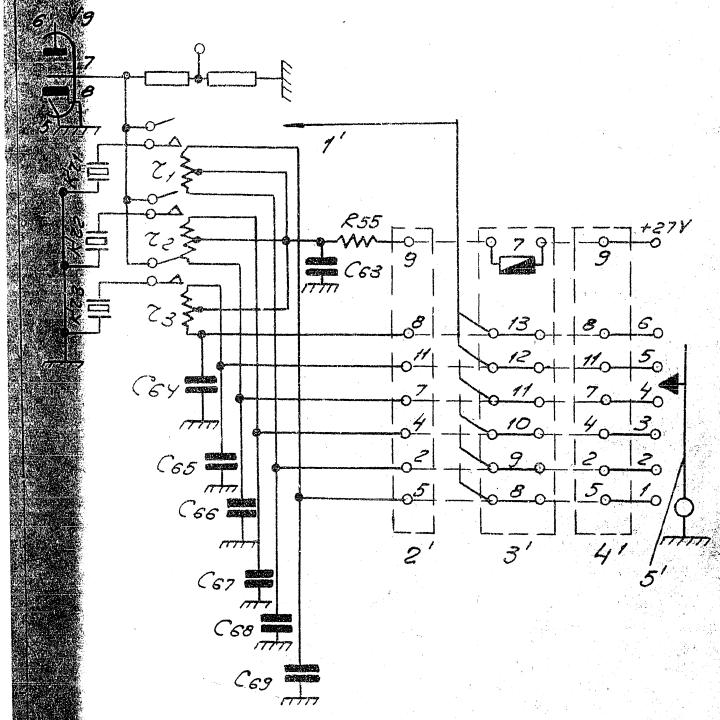

Fig. 23

1'. To course receiver 2'. 14-pole receiver connector
3'. Distribution box. 4'. 14-pole control panel connector
5'. Frequency switch.

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the operating voltage 5.0 volts. The relay windings
passed by the capacitors C_{63}, C_{64}, C_{65}, C_{66}, C_{67}, C_{68},
prevent burning of the switch contacts when crossing
he crystal to another.

Intermediate frequency amplifier

he circuit diagram of the intermediate frequency amplifier
wn in Fig. 24. The intermediate frequency amplifier
ts of three stages employing miniature pentodes type
The anode loads of the valves are intermediate frequency
s consisting of two tuned circuits which are coupled by
al capacitive coupling, according to the circuit shown
. 25, a. Tight coupling between the tuned circuits is
ed by the coupling capacitor $C_{coup.}$, ensuring a resonance
of the shape shown in Fig. 25, b. The curve is somewhat
mped with extremely steep sides.
he coils of the intermediate frequency filters are wound
celain formers. Both coils of each filter and the de-
ng circuits are assembled on a common base and closed by
minium shield. For connecting the filter to the radio -
iver circuit, the filter base is provided with special
. The general view of the intermediate frequency filter
wn in Fig. 26.
he circuit components which are assembled inside the
mediate frequency filters are encompassed by a broken
in Fig. 24 and in the circuit diagram of the radio re-
r. The numbers of the intermediate frequency filter loads
lso marked there.
he following are the functions of the various components
e intermediate frequency amplifier circuit: filter tuned-
uit components: C_{11} — L_{11}; C_{12} — L_{12}; C_{18} — L_{13}; C_{19} — [illegible]
L_{15}; C_{26} — L_{16}; coupling capacitors between tuned [illegible]
— C_{13}, C_{20}, C_{24}; decoupling components of [illegible]
— R_5, C_9, C_{70}, R_9, C_{71}, C_{16}, R_{18}, C_{22}, C_{77}; [illegible]
nents of the grid circuits — [illegible]
pling components of the [illegible]
[illegible]

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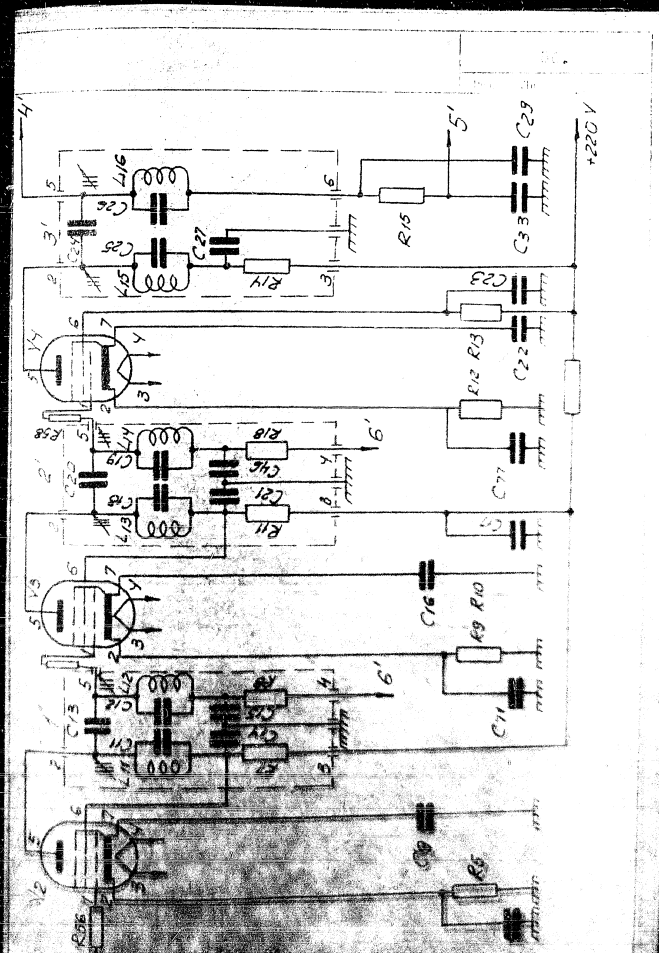

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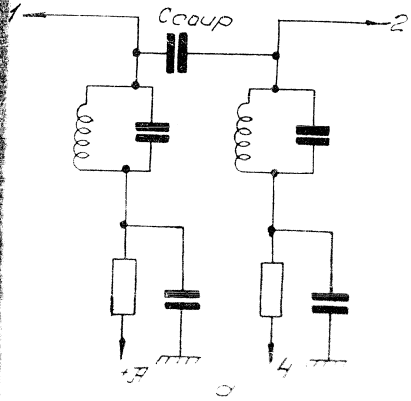

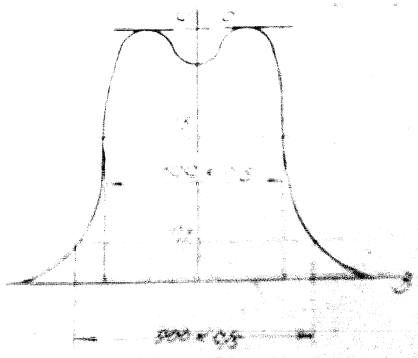

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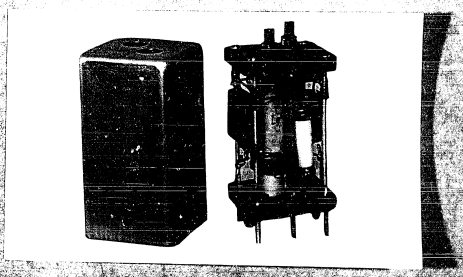

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Detector, A.G.C. rectifier, first audio frequency amplifier

The circuit diagram of this assembly is shown in Fig. 27. A feature of this radio receiver is that the first audio frequency amplifier augments the operation of the automatic gain control rectifier. The receiver detector employs the left half of the valve V_5 (6N2П) . The intermediate frequency voltage is applied to the detector anode from the circuit L_{16}--C_{26} of the fourth intermediate frequency filter. For audio frequencies and direct current the detector circuit is completed through the load resistors R_{15} and R_{16}. Voltage for the grid of the first audio frequency amplifier is taken from the resistor R_{16}. For separating the audio frequency and intermediate frequency signals the load resistors of the detector are bypassed by the capacitor C_{29}.

The A.G.C. rectifier operates with a delay, i.e. the A.G.C. operates when the signal at the detector input exceeds a definite value and does not operate with weak signals. The operation of the A.G.C. delay is explained for direct current by the simplified diagram of the circuit (Fig. 28).

In the absence of a signal, the anode current of the valve V_6 developes a voltage drop across the resistor R_{17}, which is equal to about 2.5 volts. Between the grid and the cathode of this valve the voltage drop is equal to zero, as the grid resistor of the valve R_{16} is connected between the grid and the cathode. As the main signal detector is connected in parallel with the grid-cathode section of the valve V_6, it is also at zero bias. The cathode of the A.G.C. rectifier is at + 2.5. volts with respect to the anode, i.e. the A.G.C. rectifier is cut off.

Thus the signal detector begins to operate at any weak signal, and the A.G.C. rectifier only at signals exceeding the initial bias of the valve. In the case of strong signals, a voltage drop is developed across the resistor R_{16} by the d.c. component of the detector current. This voltage drop produces a high negative bias at the grid of the valve V_6, sharply reducing its anode current. At the same time the voltage drop across the resistor R_{17}, i.e. the initial bias of the A.G.C.

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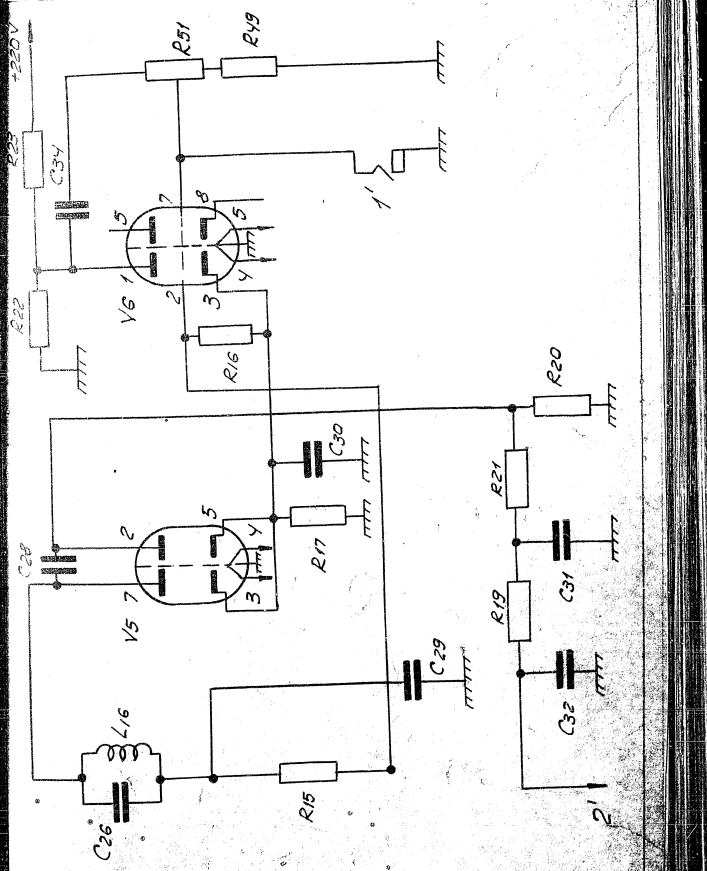

Fig. 27

1'. Tester jack 2'. To grids of intermediate frequency amplifier.

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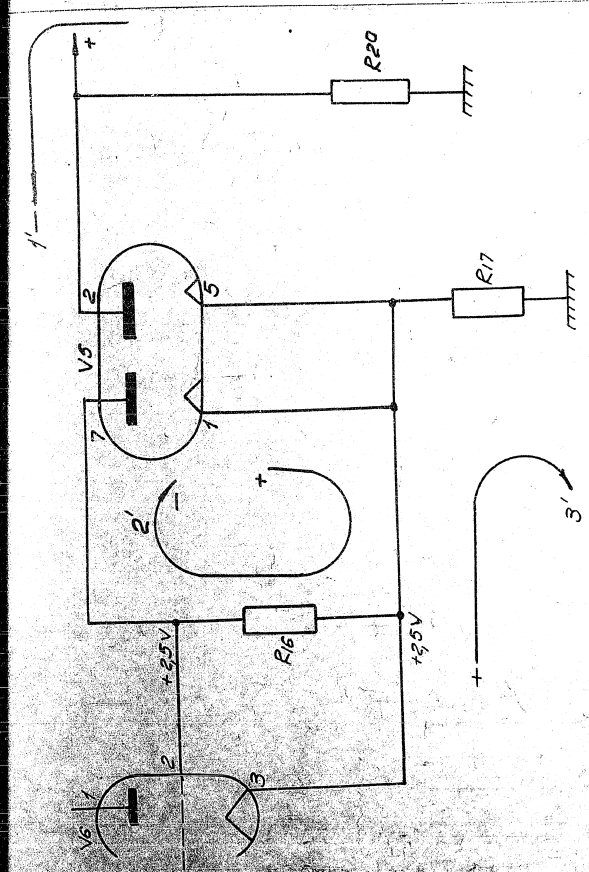

Fig. 28

1'. Current of A.G.C. rectifier 2'. Detector current
3'. Current of valve V6.

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...r, is reduced, and the operation of the A.G.C. becomes ...pronounced, i.e. the negative bias on the control grids of ... amplifier valves will increase. Thus, a delay in the ... occurs at weak signals and an amplification in the ... of the A.G.C. at strong signals.

The A.G.C. rectifier is coupled to the signal detector ... coupling capacitor C_{28} (Fig. 27). The load of the ... rectifier is the resistor R_{30}. The negative voltage ... this resistor is applied to the control grids of the inter- ... frequency amplifier valves via the filter R_{29}, R_{31}, C_{31}, ...

The characteristic of the A.G.C. of the [illegible]-2 receiver ... that with an increase in the signal at its input, the ... signal first increases and then smoothly falls off. ... operation of the A.G.C. system is determined by the ... R_{29}, R_{31}, C_{31}, C_{32}. Both meshes of this filter: R_{31}, ... R_{29}, C_{32} are charged by the rectified current of the ... rectifier during the positive half-wave when the voltage ... A.G.C. anode exceeds + 2.5 volts and discharged via the ... rectifier load R_{30} during the negative half-waves when ... diode is cut off. The time constants of these meshes are ... sufficiently high so that the charging and discharging ... filter would not proceed in step with variations in the ... value produced by modulation, and sufficiently low so ... filter would have time to charge or discharge in step ... variations in the value of the carrier caused by approach ... departure from the beacon.

The operation of the first audio frequency amplifier ... augments the operation of the A.G.C. As was mentioned ..., with strong signals at the control grid of the first ... frequency amplifier stage, a negative bias is developed ... which increases with an increase in the signal, this increase ... the signal causing a decrease in the gain of the audio fre- ...quency amplifiers. Thus automatic gain control with variation ... of the input signal is provided both in the intermediate and ... frequency amplifiers.

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For automatic gain control in audio frequency, the left-hand triode of the valve 6НП is supplied via a voltage divider (the resistors R_{22} and R_{23}), which ensures a constant anode voltage for great variations in the grid bias; this causes the gain of the stage to vary within wide limits, ensuring deep audio-frequency A.G.C.

From the anode of the first audio frequency amplifier stage, the signal is applied via a blocking capacitor C_{34} to the divider R_{51}, R_{49}. The inclusion of these resistors limits the range of gain control.

The potentiometer R_{51} of this divider controls the voltage applied to the second stage of the audio frequency amplifier. Thus sensitivity control of the receiver is provided. The sensitivity potentiometer has a slotted shaft which is located on the front panel of the receiver under a cap marked "РЕГУЛЕРОВКА" ("ADJUSTMENT"). The grid of the second audio amplifier stage is connected to the jack "ТЕСТЕР" ("TESTER") on the front panel of the radio receiver, which serves for applying an audio frequency signal when checking the radio receiver (see below).

<u>The second stage of the audio frequency amplifier and the output unit</u>

The second stage of the audio frequency amplifier (Fig. [illegible]) employs the right-hand triode of the 6НП valve V_6. The load of the valve is the parallel-connected bandpass filters of 90 and 150 c/s, the function of which is to separate [illegible] channels the modulation frequencies of the beacon. The stage employs a parallel-feed circuit. Self-bias [illegible] expense of the voltage drop across the resistor [illegible] the capacitor $C_{[illegible]}$. The 90 and 150 c/s filters consist of three tuned circuits each ([illegible] C_{43} and Tr_2, $C_{[illegible]}$). The [illegible] transformers Tr_1 [illegible] Tr_2 [illegible] 150 c/s filters [illegible] and 150 c/s, [illegible] and Tr_2 together [illegible] 90 and 150 c/s.

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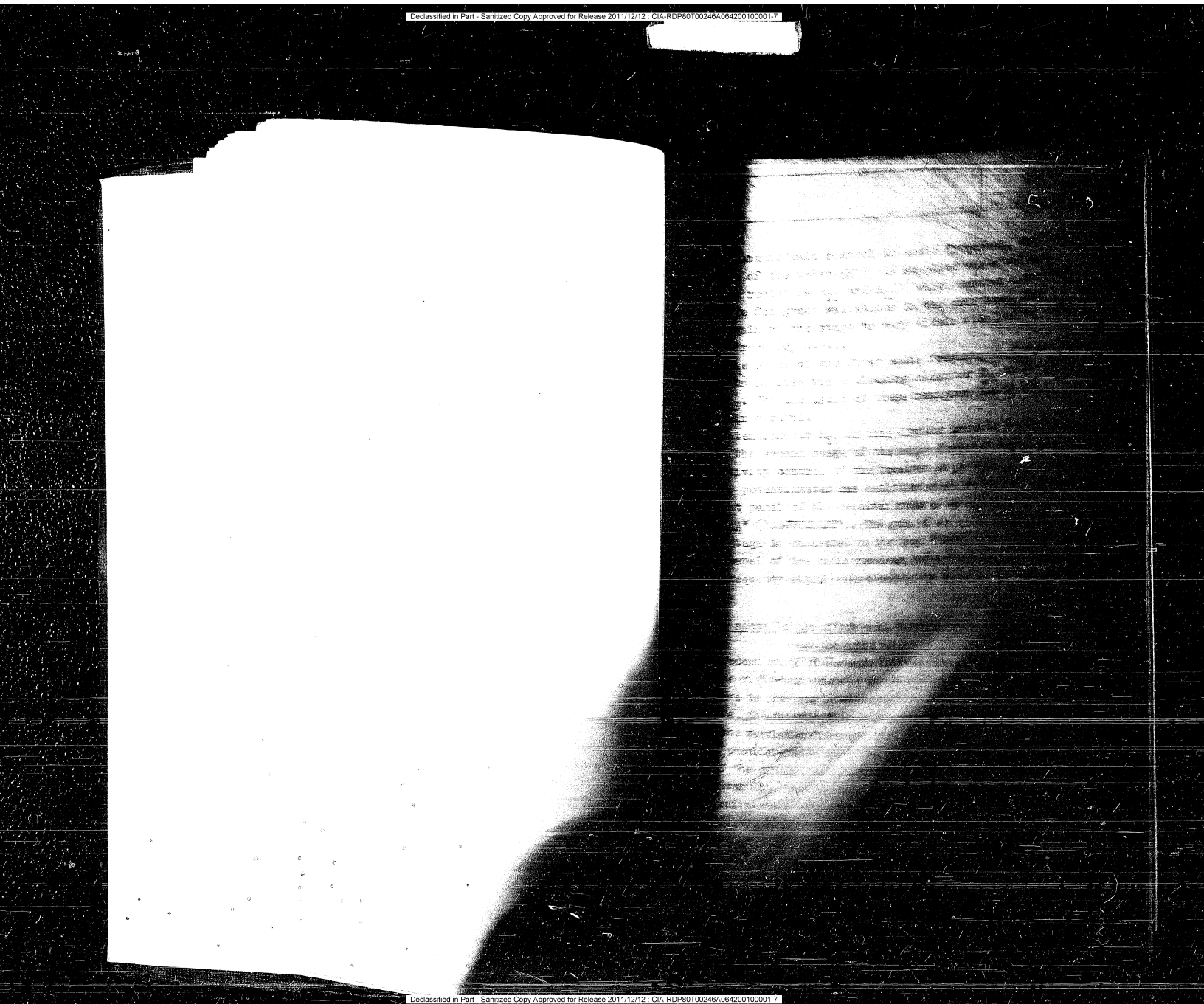

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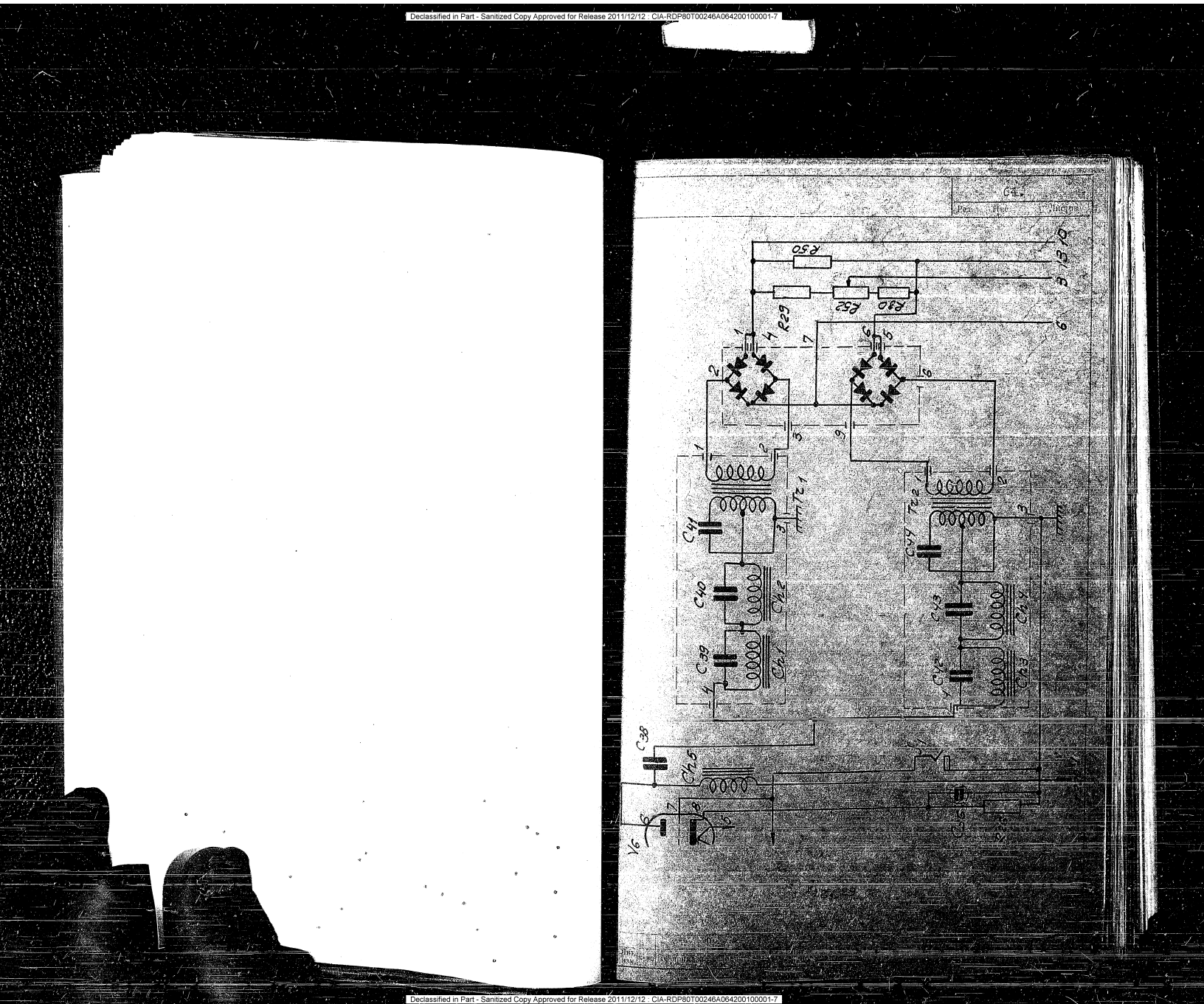

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For suppressing frequencies below and above 90 and 150 c/s, use is made of the other tuned circuits of the filters, which are wave traps and provide good attentuation of frequencies which should not be passed by the filters. In the 150 c/s filter, the choke Ch_1 and the capacitor C_{39} form a resonant circuit which attenuates frequencies higher than 150 c/s, while the choke Ch_2 and the capacitor C_{40} attenuate frequencies lower than 150 c/s. In the 90 c/s filter, the choke Ch_3 and the capacitor C_{42} attenuate frequencies higher than 90 c/s, while choke Ch_4 and capacitor C_{43} attenuate frequencies lower than 90 c/s.

The frequency response of the audio frequency filters is shown in Fig. 30. The filters and the anode choke Ch_5 are assembled in hermetical metal casings which protect them from moisture.

From the secondary windings of the transformers of the 90 and 150 c/s filters, the output voltage is applied to the bridge rectifiers which are assembled in a common casing on the upper board of which are located contacts for connection to the circuits. The output contacts of the bridge are connected to the terminals 10 and 13 of the 14-pole connector for connection to the indicator.

The potentiometer R_{52} is connected to the output of the filters for varying the output signal voltage. The circuit is balanced with the aid of this adjustment when the audio frequency amplifier is supplied with signals of 90 and 150 c/s having the same amplitudes, the indicator pointer should set in the zero position. The resistors R_{29} and R_{30} are connected in series with the potentiometer R_{52}. The potentiometer R_{52} (balance) is provided with a slotted shaft which is located on the front panel of the resolver and closed by a lid marked "РЕГУЛИРОВКА" ("ADJUSTMENT"). The resistor R_{50} is connected in parallel with the indicator and serves for branching off part of the output current. The common circuit of the two bridges, which is formed by the resistors R_{29}, R_{30} and the common point 7 of the bridge, includes the emergency signalizer.

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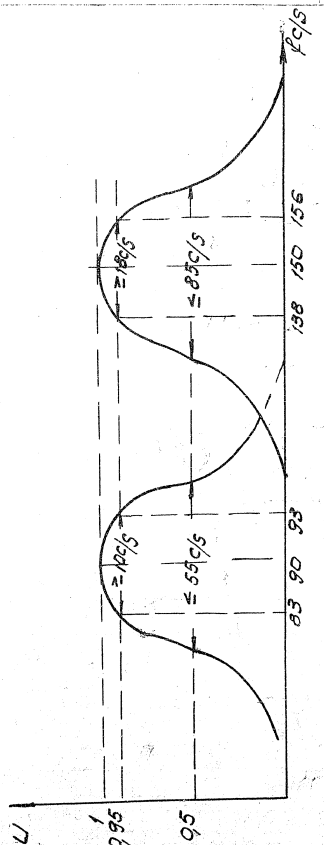

Fig. 30

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The emergency signalizer is connected to terminals 3 and 6 of the 11-pole connector.

When operating with two ПСП-48 indicators, the windings of the emergency signalizers and glide-slope indicators are connected in parallel in pairs. The connection diagram for the indicators is shown in appendix No. 13.

The КРП-5 RADIO RECEIVER

Input circuits and the radio frequency amplifier stage

The signal of the course beacon is fed along a two-conductor cable, connecting the antenna to the receiver, via the antenna connector Cn_1, to the antenna coil L_1 (Fig. 31).

The antenna coil is inductively coupled to the input circuit coil (L_2) and wound above the latter in the form of two turns with an earthed centre-tap.

In order to eliminate capacitive coupling between the input circuit coil and the antenna coil, use is made of an electrostatic screen having the shape of a brass strip wound around the input circuit coil and connected to the chassis of the radio receiver. The capacitance of the input circuit is made up of the internal capacitance of the coil L_2, the circuitry capacitance and the grid-cathode capacitance of the valve V_1.

The input circuit is tuned to the received band of frequencies with the aid of a brass slug located inside the coil L_2. The input circuit ensures the passage of the whole band of working frequencies. Via the blocking capacitor C_1, the input circuit is coupled to the grid of the radio frequency amplifier valve V_1.

The radio frequency amplifier stage employs a 6Ж1П pentode (V_1). The anode load of the radio frequency amplifier is the tuned circuit L_3, C_4. The anode circuit is earthed for radio frequencies via the capacitor C_5. The anode tuned circuit L_3, C_4 is inductively coupled to the grid coil of the [illegible]. These two coupled circuits form a bandpass [illegible] ther with the input circuit ensure the passage of [illegible]

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[illegible] signaliser is connected to terminals [illegible] and [illegible] of [illegible] connector.

[illegible] operating with two [illegible] indicators, the tiddings [illegible] emergency signalisers and glide-slope indicators are [illegible] in parallel in pairs. The connection diagram for [illegible] indicators is shown in appendix No. [illegible].

The [illegible] RADIO RECEIVER

Input circuits and the radio frequency amplifier stage

The signal of the course beacon is fed along a two-con[illegible] cable, connecting the antenna to the receiver, via the [illegible] connector [illegible], to the antenna coil [illegible] (Fig. [illegible]). [illegible] antenna coil is inductively coupled to the input [illegible] coil ([illegible]) and wound above the latter in the form of [illegible] with an earthed centre-tap.

[illegible] order to eliminate capacitive coupling between the [illegible] circuit coil and the antenna coil, [illegible] is made of an [illegible] screen having the shape of a brass strip wound [illegible] the input circuit coil and connected to the chassis of [illegible] receiver. The capacitance of the input circuit is [illegible] of the internal capacitance of the coil [illegible], the [illegible] capacitance and the grid-cathode capacitance of the [illegible].

[illegible] input circuit is tuned to the received band of fre[illegible] with the aid of a brass slug located inside the coil [illegible]. The input circuit ensures the passage of the whole band of [illegible] frequencies. Via the blocking capacitor [illegible], the input [illegible] is coupled to the grid of the radio frequency amplifier [illegible].

The radio frequency amplifier stage employs a [illegible] pentode ([illegible]). The anode load of the radio frequency amplifier [illegible] the tuned circuit [illegible]. The anode [illegible] is [illegible] radio frequencies [illegible] [illegible] is [illegible] [illegible] [illegible]

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The emergency signalizer is connected to terminals 3 and 6 of the [illegible] connector.

When operating with two ПСП-48 indicators, the windings of the emergency signalizers and glide-slope indicators are connected in parallel in pairs. The connection diagram for two indicators is shown in appendix No. 13.

The КРП-6 RADIO RECEIVER

Input circuits and the radio frequency amplifier stage

The signal of the course beacon is fed along a two-conductor cable, connecting the antenna to the receiver, via the antenna connector Cn_1, to the antenna coil L_1 (Fig. 31).

The antenna coil is inductively coupled to the input circuit coil (L_2) and wound above the latter in the form of two turns with an earthed centre-tap.

In order to eliminate capacitive coupling between the input circuit coil and the antenna coil, use is made of an electrostatic screen having the shape of a brass strip wound around the input circuit coil and connected to the chassis of the radio receiver. The capacitance of the input circuit is made up of the internal capacitance of the coil L_2, the circuitry capacitance and the grid-cathode capacitance of the valve V_1.

The input circuit is tuned to the received band of frequencies with the aid of a brass slug located inside the coil L_2. The input circuit ensures the passage of the whole band of working frequencies. Via the blocking capacitor C_1, the input circuit is coupled to the grid of the radio frequency amplifier valve V_1.

The radio frequency amplifier stage employs a [illegible] pentode (V_1). The anode load of the radio frequency amplifier is the tuned circuit L_3, C_4. The anode circuit is [illegible] for radio frequencies via the [illegible] L_3, C_4 is inductively coupled [illegible] These two coupled circuits [illegible] ther with the input [illegible]

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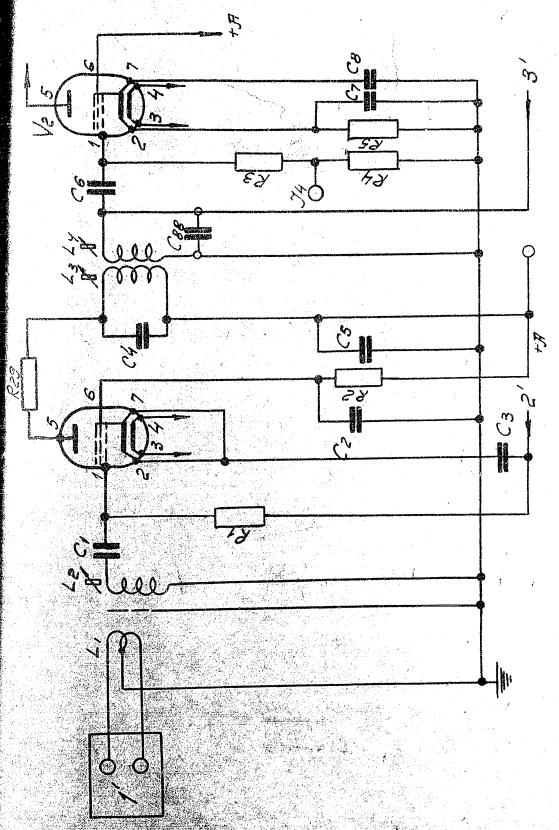

Fig. 31

1'. C_{M_1} 2'. A.G.C. 3'. From local oscillator

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[illegible] frequencies [illegible] the attenuation of symmetrical [illegible] than [illegible]. The bandpass filter is tuned [illegible] of brass slugs located in the coils [illegible] and [illegible].

[illegible] is supplied to the screen grid of the valve V_1 via [illegible] resistor R_2, which is bypassed by the capacitor C_2. [illegible] voltage is supplied to the control grid of the [illegible] from the [illegible] circuit via the grid resistor R_1. The [illegible] of the valve V_1 includes the resistor R_{29} for in[illegible] stability of the radio frequency amplifier.

[illegible] circuit and the radio frequency amplifier provide [illegible] times.

[illegible]

[illegible] stage employs a single-grid conversion circuit [illegible] valve V_2 (Fig. 38).

[illegible] received radio frequency signal, amplified by the [illegible], and the radio frequency voltage from the local [illegible] are applied to the control grid of the valve V_2, [illegible] C_{52} and C_{91}, respectively. The local oscillator [illegible] selected lower than that of the received signal. [illegible] of the local oscillator frequency and that of the [illegible] signal produces the intermediate frequency.

[illegible] circuit of the mixer includes the first inter[illegible] frequency bandpass filter. The anode tuned circuit is [illegible] the inductance L_5 and the capacitors C_9 and C_{10}. The [illegible] consisting of the resistor R_8 and the capacitor C_{14} is [illegible] circuit for the mixer anode. In series with the [illegible] anode is connected the resistor R_6 for suppressing high [illegible] parasitic oscillations which may develop due to the [illegible] of parasitic coupling in the circuitry. For the same [illegible], the resistor R_{33} is connected in series with the grid of the valve V_3. Voltage is supplied to the screen grid via the [illegible] resistor R_7. The screen grid is bypassed by the capacitor C_{13}.

[illegible] bias is developed across the cathode resistor R_5. The [illegible] cathode is bypassed for radio frequencies by the capacitors C_7 and C_8.

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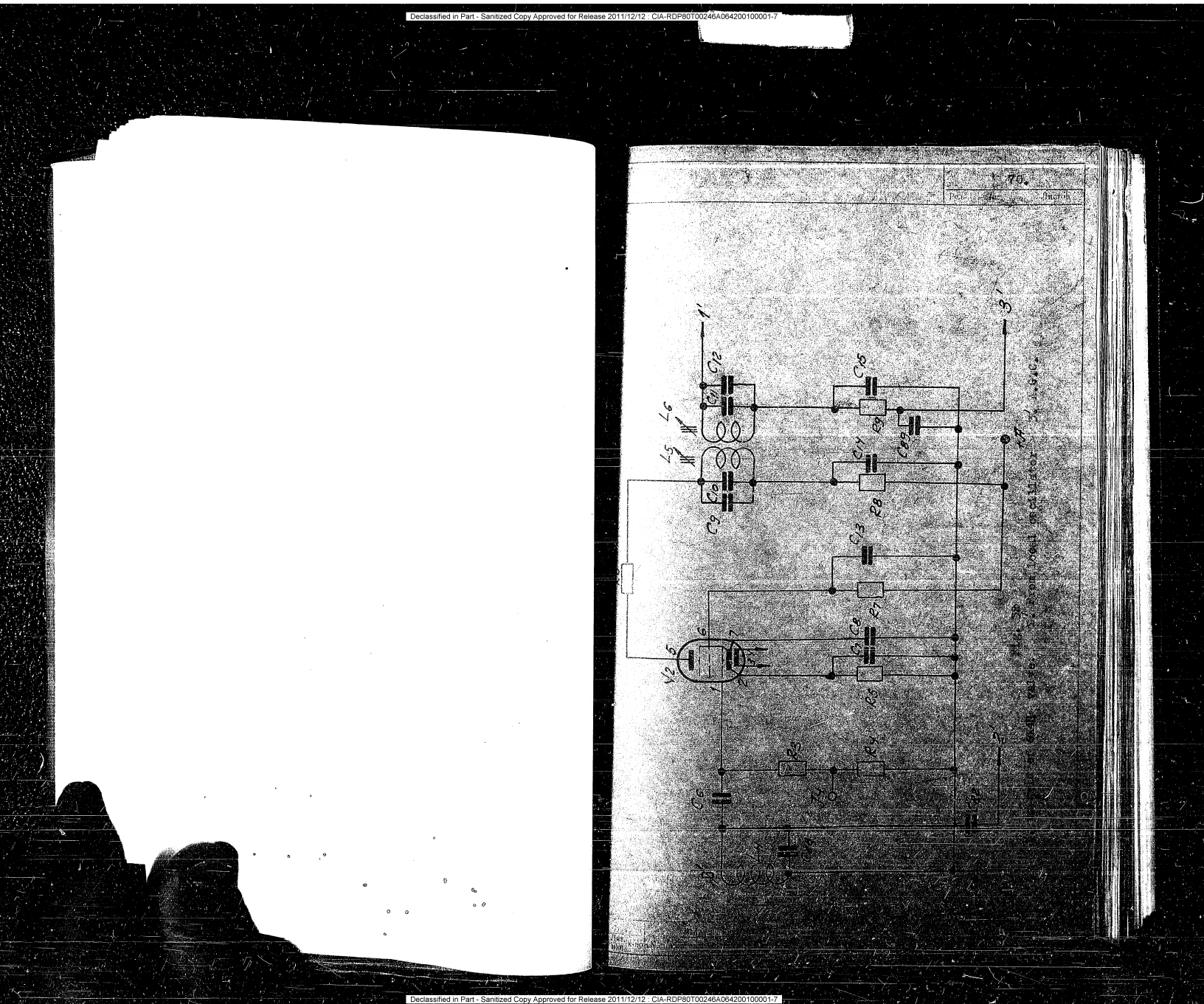

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The resistors R_3 and R_4 are leak resistors. The resistor is very low compared to R_3 and is included to allow measur- of the mixer grid current when aligning the receiver, with- t breaking the grid circuit. For convenience in connecting e microammeter, a jack I_4 is provided on the valve side of e receiver chassis, which is connected to the junction of the sistors R_3 and R_4.

The intermediate frequency is selected high so as to obtain fficient image (symmetrical) frequency rejection. The image annel is removed by twice the intermediate frequency from e working channel.

The frequency of the image channel is lower than that of e working channel, as the local oscillator frequency is hosen lower than the received-signal frequency.

LOCAL OSCILLATOR

The local oscillator contains a master oscillator and ree frequency multiplication stages, employing the valves 6Ж3Б and 6Ж4П (Fig.33).

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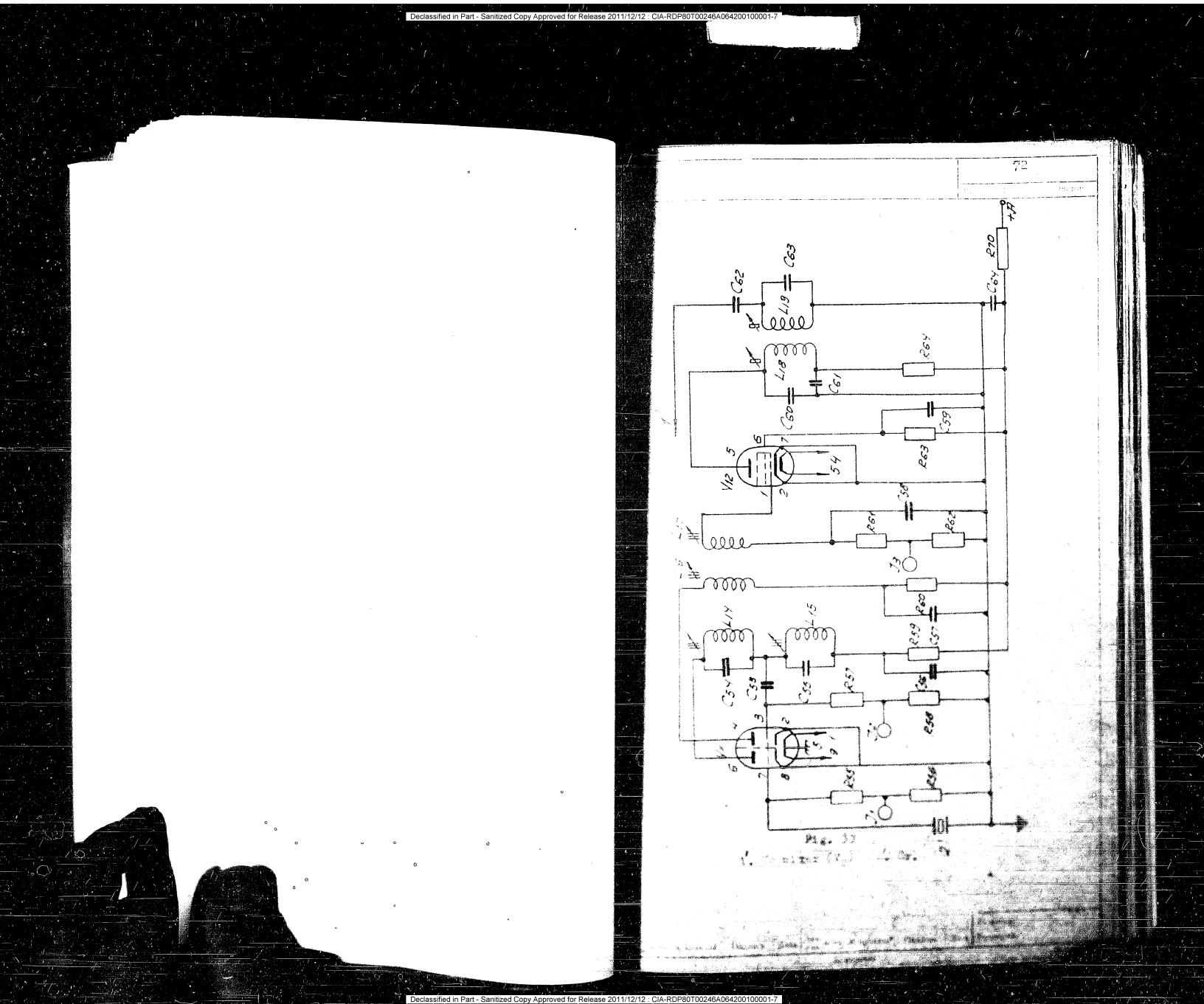

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e left triode of the 6Н3П valve (V_{11}) serves as the master scillator. One of the crystals (Cr_1, Cr_2, Cr_3, Cr_4, Cr_5, Cr_6) is nnected to the grid circuit of this triode with the aid of a lay.

The crystal connection diagram is shown in Fig.34. The crystals are connected remotely by means of relays located inside the ceiver. One or another of the relays is switched in with the aid f a switch on the control panel. The relay windings are bypassed y the capacitors C_{65}, C_{66}, C_{67}, C_{68}, C_{69}, C_{70}, C_{71}, so the contacts of the switch on the control panel would not burn when switching from one crystal to another.

The tuned circuit in the grid circuit of the master oscillator is a crystal. The anode circuit of the master oscillator includes the tuned circuit L_{14}, C_{54}. Feedback is provided by the rid-anode capacitance. This stage of the local oscillator simultaneously serves as a tripler of the crystal frequency.

The operating conditions of the master oscillator ensure he optimum grid current cut-off angle for producing the third harmonic of the crystal frequency.

The anode circuit of this stage includes, in series with he tuned circuit (L_{14}, C_{54}) across which the first harmonic of he crystal frequency is developed, the resonant circuit L_{15}, C_{55}, tuned to the third harmonic. The third harmonic voltage developed across the circuit L_{15}, C_{55} is applied to the grid of the right-hand triode of the valve V_{11} via the capacitor C_{58}.

The grid circuits of the master oscillator and frequency multipliers include the grid leak resistors R_{55}, R_{57}, R_{61}. For measuring the grid currents of the stages when aligning the local oscillator, low-ohm resistors (R_{56}, R_{58}, R_{62} of 1.5 kohms are connected in series with the main leak resistors and their high potential junctions wired to the jacks J_1, J_2, J_3, located on the valve side of the receiver chassis.

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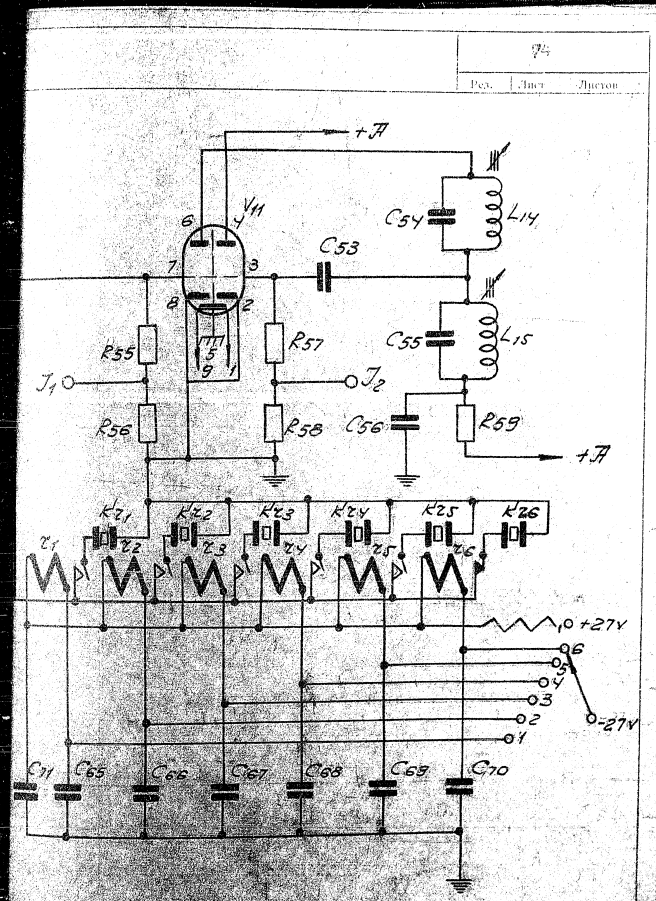

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[illegible] the local oscillator, the minus terminal of [illegible] is connected to these jacks. The resistor R_{59} [illegible] C_{56} serve for decoupling the anode.

[illegible] anode circuit of the right-hand triode of the valve [illegible] the inductance L_{16}, which together with the output [illegible] of the triode forms a resonant circuit tuned to the [illegible] of the crystal frequency.

[illegible] resistor R_{60} and capacitor C_{57} form a circuit for [illegible] the anode.

[illegible] coil L_{16} is inductively coupled to the coil L_{17}, which [illegible] the input capacitance of the valve V_{12}, forms a [illegible] circuit which is also tuned to the 9th harmonic of the [illegible] frequency.

[illegible] both circuits, tuned to the 9th crystal harmonic form [illegible] filter, which ensures uniform passage of the whole band [illegible] frequencies and sufficient attenuation of all other [illegible].

The frequency doubler stage employs a 6Ж1П valve (L_{12}). [illegible] circuit of this valve includes a bandpass filter made [illegible] circuits formed by the inductances L_{18}, L_{19} and capacitors [illegible] C_{63} tuned to the 18th harmonics.

The grid circuit of the valve V_{12} includes the grid leak [illegible] R_{61} and R_{62} bypassed by the capacitor C_{58}. The resistor [illegible] the capacitor C_{61} serve for decoupling the anode circuit [illegible] valve V_{12}.

The capacitor C_{61} is selected such as to form together with the inductance L_{18} a series tuned circuit which presents a low impedance for the lower harmonics of the crystal frequency, forming a filter mesh for them. Voltage is supplied to the screen grid of the valve V_{12} via the dropping resistor R_{63}; the screen grid is bypassed by the capacitor C_{59}.

The 18th-harmonic resonant circuit is tuned by means of brass slugs which are screwed inside the coils L_{18} and L_{19}.

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stage of the 18th harmonic is applied from the second tuned circuit of the bandpass filter to the grid of the mixer valve, via the blocking capacitor C_{62}.

Intermediate frequency amplifier

The intermediate frequency amplifier contains two stages employing 6K4Π valves (V_3 and V_4, Fig. 35).

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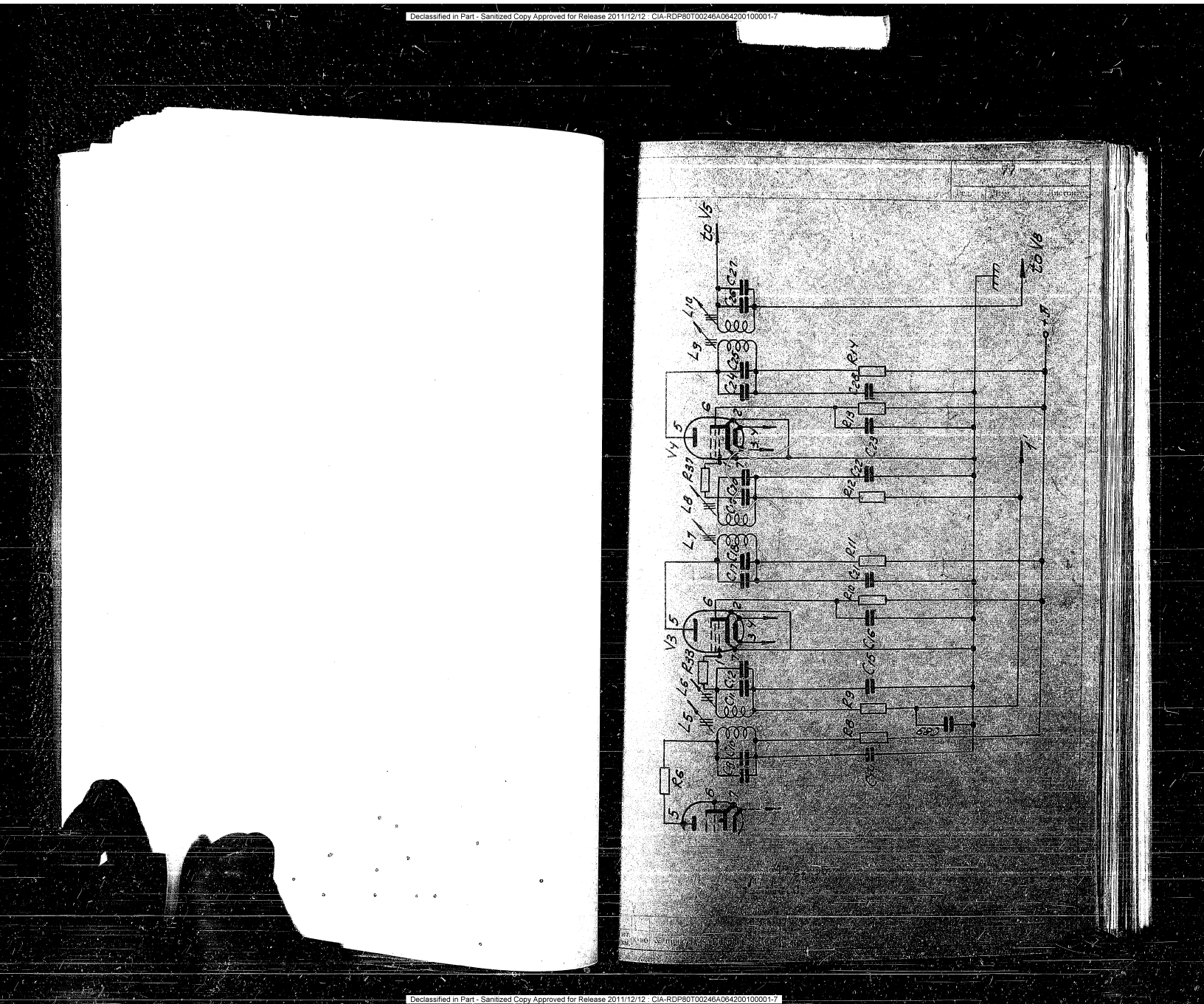

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grid tuned-circuit I of the intermediate frequency fil-
ts of the inductance L_6 and the capacitors C_{11} and C_{12}
the grid circuit of the first I.F. amplifier valve.
bias is applied to the grid of the valve V_3 from the
d unit via the resistor R_9. The resistor R_9 and the
C_{15} form a filtering circuit.

resistor R_{35} is an antiparasitic resistor.
age is applied to the screen grid of the valve V_3 via
ng resistor R_{10}. The screen grid is bypassed by the
C_{16}. The first and second stages of the intermediate
amplifier are coupled by means of the filter II. The
ned-circuit of this filter is formed by the inductance
capacitors C_{17}, C_{18}; the grid tuned circuit by the
L_8 and the capacitors C_{19}, C_{20}. The anode and grid
are inductively coupled and tuned to the intermediate

intermediate frequency bandpass filters are tuned by
carbonyl-iron slugs. The resistor R_{11} and the capacitor
circuit for decoupling the anode of the valve V_3.
valve V_4 is employed in the second stage of the inter-
frequency amplifier. Negative bias is applied to its
the A.G.C. circuit via a filter formed by the resistor
the capacitor C_{22}. The resistor R_{37} is an antiparasitic
. Voltage is supplied to the screen grid via the dropping
R_{13}, bypassed by the capacitor C_{23}.

anode circuit of the valve included the intermediate
ency bandpass filter III. Its anode tuned circuit is formed
inductance L_9 and the capacitors C_{24}, C_{25}. The resistor R_{14}
capacitor C_{28} serve for decoupling the anode of the valve

second tuned circuit of the filter, formed by the induc-
L_{10} and the capacitors C_{26} and C_{27}, is included in the second
circuit (left diode of the valve V_5). Each stage of the
diate frequency amplifier has a gain of the order of 40.

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Detector

The detector stage employs an ordinary diode detector circuit using the left diode of the 6X2Ш valve (V_5, Fig. 36).

Intermediate-frequency voltage is applied from the 3rd intermediate-frequency filter to the anode of the left diode of the valve V_5. The audio frequency signal of 60 c/s of the variable-phase radiation and the audio-frequency signal of 10 kc/s, frequency modulated by 60 c/s, of the constant-phase radiation, are developed across the detector load (R_{17}) bypassed by the capacitor C_{31}.

From the receiver input to the detector, the signals of the constant-and variable-phase radiations are amplified simultaneously in one channel. After the detector, the signals are separated and amplified subsequently by separate channels.

Separation is obtained with the aid of the filtering circuit consisting of the components C_{29}, R_{15}, R_{16}, C_{30}. The value of the capacitor C_{29} is selected such that it would present a low reactance for the 10-kc/s voltage and a high reactance for the 60 c/s voltage.

The resistors R_{15} and R_{16} are leak resistors of the [illegible] V_8. For the 60-c/s voltage not to [illegible] the valve V_8 from the detector load, the bypass [illegible] C_{30} is included.

The 10-kc/s frequency-modulated voltage [illegible] the detector load is applied via the capacitor [illegible] grid of the triode V_8, the first audio frequency [illegible] of the constant-phase channel.

The filtering circuit does not [illegible] ation frequency. Voltage of 60 c/s is [illegible] C_{42} to the control grid of [illegible] the first audio frequency [illegible] channel.

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From the receiver input to the detector, the signals of the constant-and variable-phase radiations are amplified simultaneously in one channel. After the detector, the signals are separated and amplified subsequently by separate channels.

Separation is obtained with the aid of the filtering circuit consisting of the components C_{29}, R_{15}, R_{16}, C_{30}. The value of the capacitor C_{29} is selected such that it would present a low resistance for the 10-Kc/s voltage and a high resistance for the 60 c/s voltage.

The resistors R_{15} and R_{16} are leak resistors of the valve V_8. For the 60-c/s voltage not to penetrate to the grid of the valve V_8 from the detector load, the bypass [illegible] C_{30} is included.

The 10-Kc/s frequency-modulated voltage [illegible] the detector load is applied via the capacitor [illegible] grid of the triode V_8, the first audio-frequency [illegible] of the constant-phase channel.

The filtering circuit [illegible] lation frequency, [illegible] C_{42} to the control [illegible] the first audio [illegible] channel.

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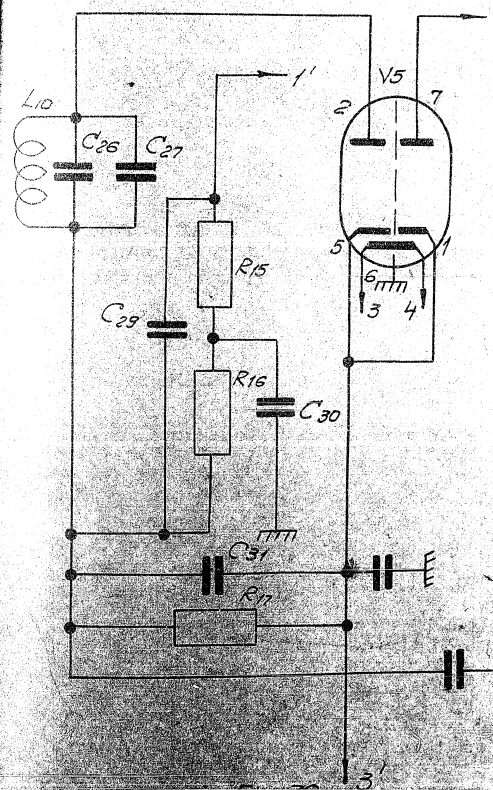

Fig 56

1 To 7th pin of ½ 12 To 2nd pin of V8.

3 To Blue terminal

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Automatic Gain Control

[illegible] receiver employs delayed automatic gain control. [illegible] anode of the valve 6[illegible] (V_6) is the A.G.C. recti- [illegible] circuit diagram of the A.G.C. circuits is shown in Fig.

[illegible] resistors R_{68} and R_{69}, which serve as the load of the [illegible], are included in the A.G.C. circuit. The passage [illegible] current of the bias generator through the resis- [illegible] (see Fig.37) develops a negative potential of the [illegible] volts with respect to the receiver chassis.

[illegible] initial negative bias (-1.2 v) is applied to the con- [illegible] the valves V_1, V_3, V_4 from the resistor R_{69} via [illegible] R_{21} and the filtering circuit R_{19}, C_{33}, R_{18}, C_{89}. [illegible] by the bias-generator current across the resis- [illegible] applied to the anode-cathode points of the A.G.C. [illegible] (V_6) in such a way that the diode anode would have a [illegible] potential with respect to the cathode.

[illegible] view of the fact that the internal resistance of the [illegible] of V_{13}, the bias generator, shunts the resistors [illegible] the cathode current of the valve V_6 flows through the [illegible] R_{20}, R_{67} and the internal resistance of the diode sec- [illegible] V_{13}, with the main voltage drop occurring across the [illegible] R_{20}.

The voltage drop developed by the cathode current of the [illegible] V_6 across the resistor R_{20}, is applied to the points: [illegible] (-) and cathode (+) of the right-hand diode. This voltage is greater than the voltage from the bias generator across the resistor R_{68} and has a negative polarity.

Thus, the anode of the A.G.C. diode is under a negative potential (of the order of 50 v) with respect to the cathode. [illegible] normal signal is applied to the receiver input, the A.G.C. diode is cut off and the grids of the controlled valves are supplied only with the initial bias (-1.2 v) from the resistor R_{69}.

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Negative bias for the control grid of the 6Ж2П valve is provided by the voltage drop across the resistor R_{17} on passage through it of the d.c. component of the left-hand diode current.

With an increase in the signal applied to the receiver input, and consequently, that applied to the diode, the d.c. component of the left-diode current increases. This in its turn causes an increase in the negative bias at the control grid of the left triode of the valve V_8.

As a result of the increase in the negative bias at the control grid, the anode current of the triode decreases and, correspondingly, the cathode current decreases. The decrease in the cathode current flowing through the resistor R_{20} causes a decrease in the voltage drop across it. As the voltage at the anode of the right-hand diode with respect to the cathode is equal to the difference between the voltages developed across the resistor R_{60} on passage through it of the current from the bias generator and across the resistor R_{20} on passage through it of the cathode current of the valve (V_8), at a certain instant it can become positive with respect to the cathode. Such an instant occurs when a signal of the order of 20 MV is applied to the receiver input.

When a signal of more than 20 MV is applied to the receiver input, the right-hand diode opens and the A.G.C. begins to operate: in this case the current of the right diode produces a voltage drop across the resistor R_{21} having the polarity shown in Fig.37.

Thus when a strong signal is applied to the receiver input, the negative bias at the control grids of the controlled valves increases and the receiver gain decreases. This makes it possible with great variations in the input signal to maintain a constant output signal level.

Bias Generator

The automatic gain control system (A.G.C.) used in the receiver, requires for its operation a constant negative voltage

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...V. In order to obtain this voltage without expendi-
...high voltage supplied by the dynamotor, use is made
... radio-frequency oscillator and rectifier, which form
...verter.

...bias-voltage generator employs the valve 6Н3П (V_{13}).
...The right hand triode of the valve is used for the radio
... oscillator, the left-hand triode for rectifying the
...ency voltage.

... oscillator employs a conductively coupled Hartley
...he tank circuit consists of the inductance L_{21} and the
... C_{74} and is tuned to a frequency of approximately 200
...grid is coupled to the tank circuit via the capacitor
... resistor R_{66} and capacitor C_{75} form a circuit for de-
... the anode.

The resistor R_{65} is a grid leak. Radio frequency voltage
... tank circuit is applied to the anode of the left half
...alve V_{13} via the capacitor C_{37} and by means of the coil
...e is inductively coupled to the tank circuit coil L_{21}.

The left half of the valve serves as a diode for rectify-
...oscillations of the bias oscillator.

The resistor R_{67} together with the capacitors C_{76} and
... form the rectifier filter. Rectified voltage from the resis-
...or R_{68} is applied to the cathode of the valve V_5.

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1. Po cathode of

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The preamplifier of the constant-phase channel

The preamplifier of the constant-phase channel employs the left half of the valve 6Н2П (V_8) and serves for amplifying the 10-Kc/s (frequency-modulated) voltage developed across the detector load. The 10-Kc/s voltage is applied via the capacitor C_{29} to the grid of the valve V_8. The amplified 10-Kc/s voltage is taken from the anode load resistor R_{22} and applied via the blocking capacitor C_{34} to the grid of the left triode of the valve V_6, which is an amplifier of the 10-Kc/s frequency and, together with the limiter, serves for eliminating parasitic amplitude modulation (Fig.39).

The negative bias developed across the detector load (R_{17}) is applied to the control grid of the valve V_8 via the resistors R_{16} and R_{15}. The negative bias at the grid of the left-hand triode of the valve V_6, developed across the resistor R_{24} in the cathode circuit, is applied via the grid leak resistor R_{23}.

The resistor R_{24} is not bypassed by a capacitor for the purpose of obtaining current negative feedback. The use of negative feedback decreases the gain of the stage but reduces nonlinear distortions. Sufficient voltage for normal operation of the limiter is supplied to the grid of the 2nd limiter stage from the anode load (R_{26}).

Limiter

As the 10-Kc/s signal always possesses some parasitic amplitude modulation due to the action of atmospheric and industrial interference, as well as of noise and distortion within the receiver, a limiter which serves for eliminating amplitude modulation is employed in front of the discriminator. The use of a limiter ensures that a signal of constant amplitude is applied to the discriminator.

The limiter employs a 6Н2П valve (V_6, Fig.39). Limiting by the left-hand triode of the valve V_6 is obtained through the

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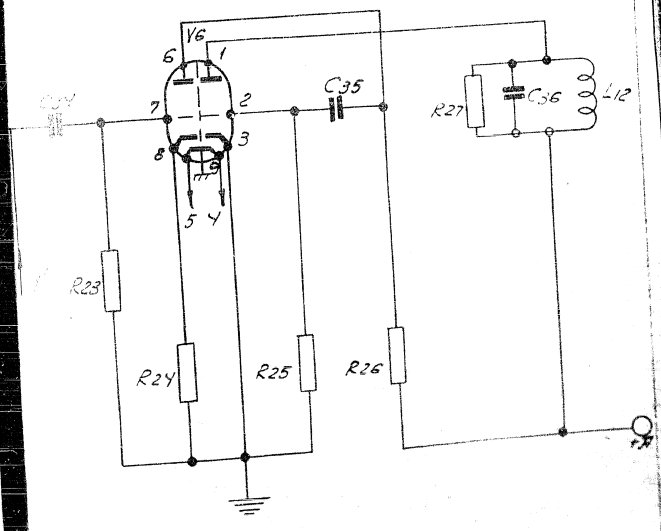

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cutting-off of the anode current at the bottom part of the anode characteristic. Limiting by the right-hand triode of the valve V_6 is the result of grid detection of the signal applied to the limiter grid.

The grid circuits of each triode include the leak resistors R_{23} and R_{25}. The D.C. component of the voltage across the resistor R_{25} has the shape of the envelope of the 10-Kc/s voltage, i.e. the grid bias varies in step with amplitude variations of the 10-Kc/s voltage.

The left triode of the valve V_6 clips the parasitic amplitude modulation of one half-wave of the signal (see Fig.40,b), [illegible] the voltage across the anode load of the stage R_{24} constant in amplitude.

The right-hand triode of the valve V_6, the load of which is the discriminator tuned circuit, limits the second half-wave of the signal, since the signal is applied to the grid of the right-hand triode of the valve V_6 in anti-phase with respect to the phase of the signal at the grid of the left-hand triode (Fig.40, c).

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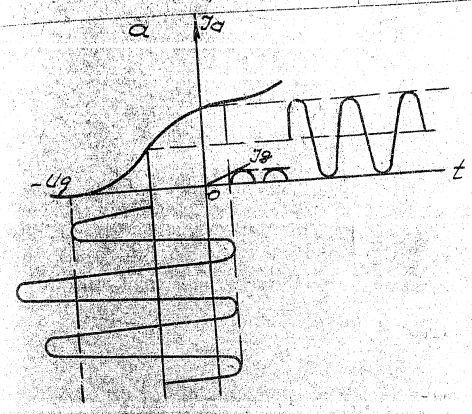

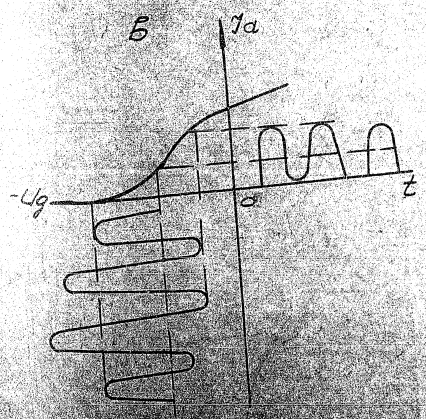

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...ns a 10-Kc/s voltage having a constant amplitude is ...cross the discriminator tuned circuit C_{36}, L_{12}. ... the stages occurs when the amplitude of the voltage ... the limiter control grid exceeds a definite value, ...e limiting threshold.

...g. 41 shows the limiter characteristics, where C_{in} is ... applied to the limiter grid, U_{out} the voltage across ... circuit of the limiter, U_{th} the voltage corresponding ...iting threshold.

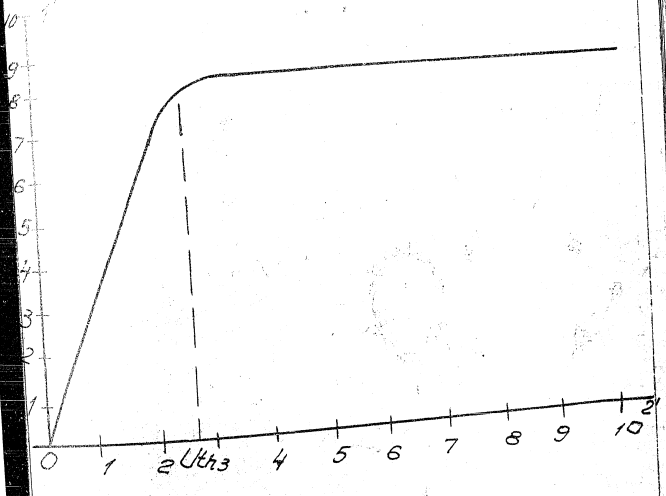

Fig. 41

1'. U_{out} (volts) 2'. U_{in} (volts)

Разработ. Проверил Лит. изм. к-во № приказа Подпись Дата Лит. изм. к-во № приказа Подпись Дата Копировал Формат

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s seen from the characteristic, hardly any variation on
on the voltage across the limiter anode load during
variations in the amplitude of the A.C. voltage applied
limiter grids.

a signal voltage, the frequency of which varies, is
across the anode circuit, a tuned circuit possessing a
resonance curve might cause amplitude modulation of the
, therefore the resonance curve is flattened by shunting
tuned circuit with the resistor R_{27}.

Discriminator

Fig.42

frequency-modulated signal is a signal the frequency
ch varies within certain limits around the middle frequency
ording to a definite law. The maximum diversions of the fre-
uency from its middle value is known as frequency deviation.

In our case the middle frequency is 10 Kc/s, and the
viation is $\pm$ 1 c/s, i.e. the frequency varies within 9 to 11
. Frequency modulation is obtained by means of a sinusoidal
of 50 c/s.

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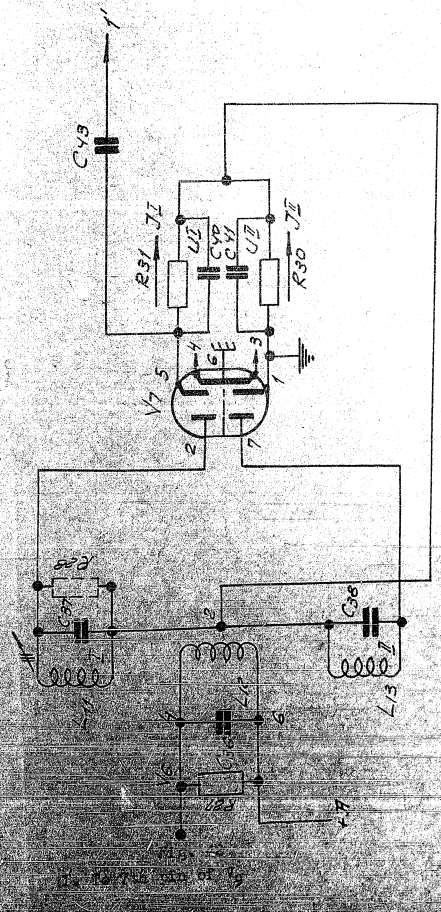

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The voltage variation curve is shown in Fig.43. The [illegible] the frequency-modulated signal is shown in Fig.44.

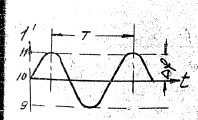

Fig. 43

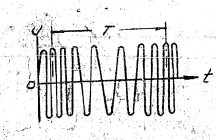

Fig. 44

1.F Kc/s

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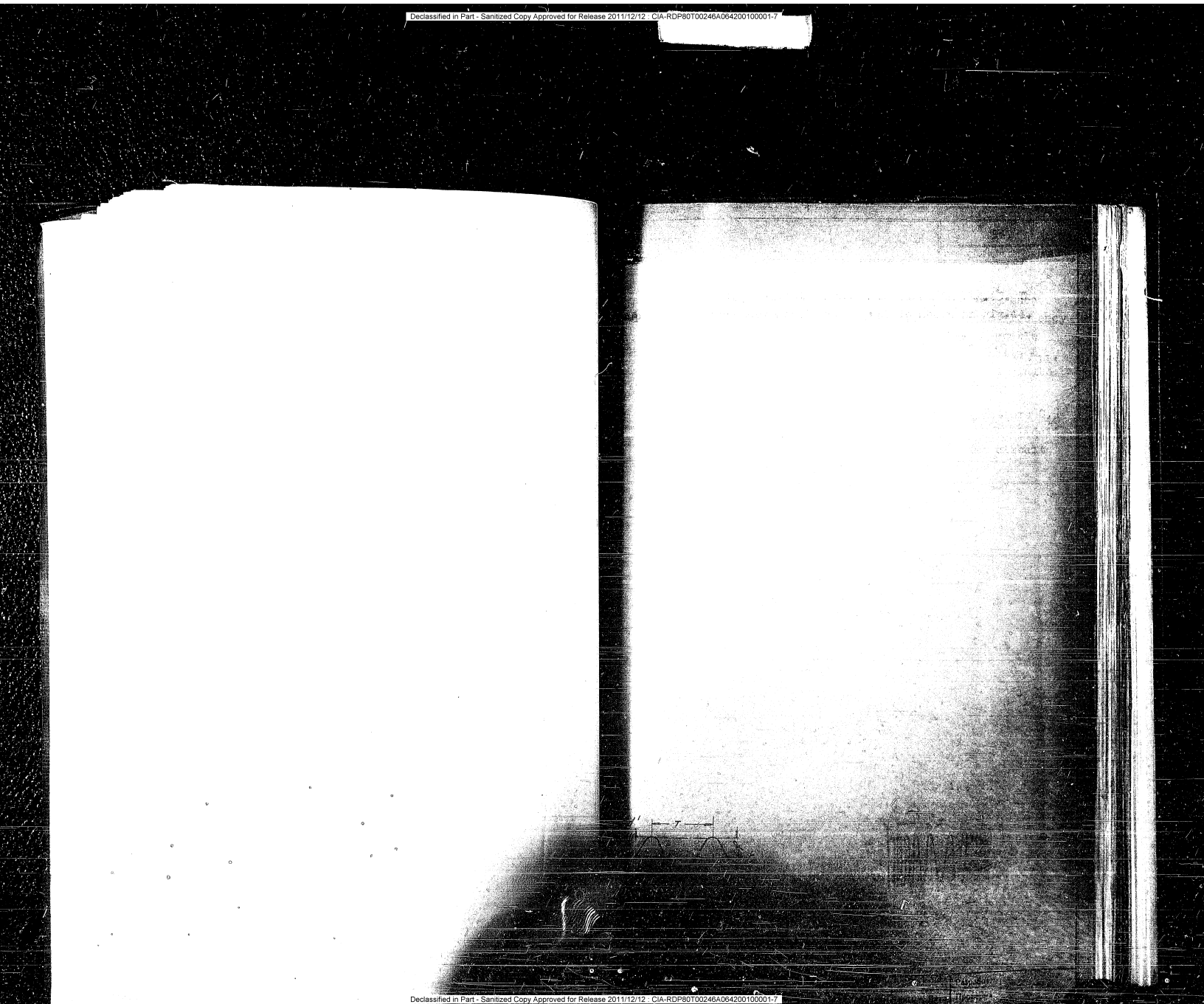

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The voltage variation curve is shown in Fig.43. The ... frequency-modulated oscillation is shown in Fig.44.

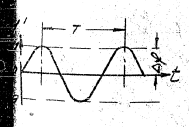

Fig. 43

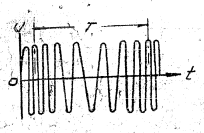

Fig. 44

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...iscriminator serves for converting the frequency ...nal into voltage of the initial modulated frequency ... The discriminator stage (Fig.42) employs a double ... (T_8) in a discriminator with two tuned circuits T_{11}, ... T_{38}, which are detuned with respect to the middle ... of 10 Kc/s.

... resistors R_{30} and R_{31} bypassed by the capacitors C_{44} ... spectively, are the loads of the diodes. The circuit ... tuned to a frequency of 7.5 Kc/s, and the circuit ... to 12.5 Kc/s (Fig.45).

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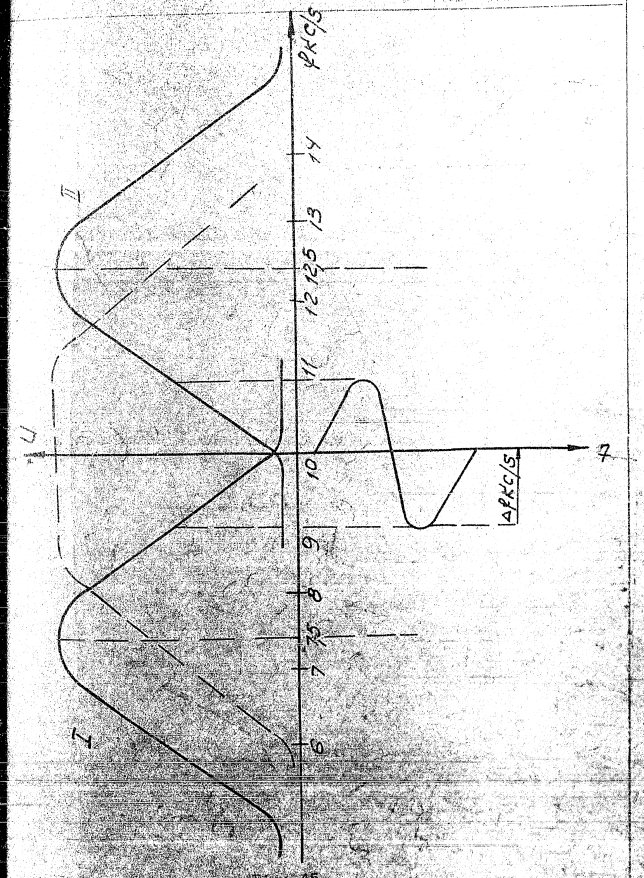

Рис. 45

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[illegible] circuit L_{12}, C_{36} [illegible] a flat resonance [illegible] and is inductively coupled to the Ist and 2nd tuned [illegible] the discriminator, is tuned to 10 Kc/s. As the circuit [illegible] symmetrically detuned with [illegible] the middle frequency [illegible] of the voltages developed across them [illegible] equal only when a frequency of exactly 10 Kc/s obtains [illegible] the tuned circuit L_{12}, C_{36}.

[illegible] the frequency of the voltage applied from the tuned [illegible] L_{12}, C_{36} increases above 10 Kc/s, the voltage across [illegible] tuned circuit increases, since the detuning of this circuit [illegible] respect to the higher frequency decreases. From the [illegible] view of the Ist circuit which is tuned to a frequency [illegible] Kc/s, the detuning increases, with the result that the [illegible] across the Ist decreases.

When the frequency of the voltage decreases below 10 Kc/s, [illegible] voltage across the Ist circuit will increase, and that across [illegible] circuit decrease. As a result, the anodes of the valve [illegible] will be supplied with a frequency modulated voltage of 10 Kc/s, [illegible] amplitude of which varies with the frequency of the initial [illegible] modulating voltage.

The diodes of the valve V_7 operate as ordinary diode detectors. The rectified voltage is developed across the discriminator load (resistor R_{30} and R_{31}). The load resistors are connected in such a way that their rectified currents are opposed. [illegible] The 60 c/s voltage applied to the audio frequency amplifier ([illegible] pin of V_9) will be equal to the difference between the two rectified voltages U_1 and U_2.

If we follow the variation in the voltage across the discriminator load caused by variation in the frequency of the signal applied to the discriminator input, we obtain a discriminator characteristic (Fig.46). As the discriminator characteristic is practically linear within ± 1.5 Kc/s, the frequency modulated signal will be detected with low distortions.

From the discriminator load, the 60 c/s A.C.voltage is applied via capacitor C_{43} to the grid 7 of the valve V_9 of the constant-phase channel.

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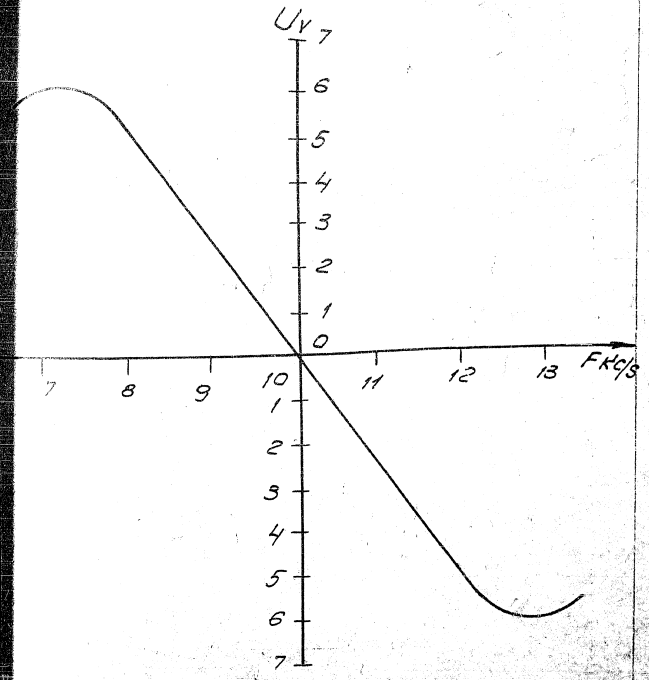

Fig. 46

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Amplifier of constant phase channel

The amplifier of the constant phase channel employs the [illegible] triode of the valve 6N3N (V_9) and is a resistance [illegible] radio frequency amplifier with negative feedback (Fig.47)

The bias voltage obtained across the resistor R_{39} in the [illegible] circuit is applied to the grid of the left triode of V_9 [illegible] grid leak resistor R_{59}.

For obtaining negative feedback, the resistor R_{39} is not [illegible] by a capacitor. From the anode load resistor R_{58} the [illegible] signal is applied via the capacitor C_{39} to the centre [illegible] the variable-phase transformer. The capacitor C_{47} serves [illegible] compensating the additional phase shift between the constant- [illegible] variable-phase signals, caused by the RC circuit (R_{52}, R_{53} [illegible] C_{39}). The capacitor C_{49} and the resistor R_{45} serve for [illegible] coupling the anode circuit of the valve V_9.

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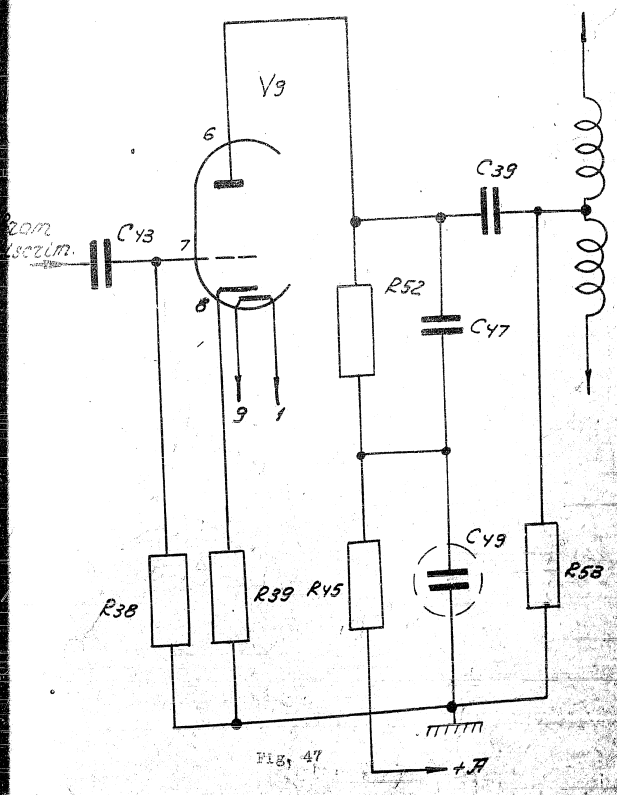

Fig. 47

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Amplifier of the variable-phase channel

The amplifier of the variable-phase channel consists of ... (Fig.40). The first stage employs one right-hand triode ... 6Н8П (V_8), the output stage the right-hand triode of ... 6Н1П (V_9).

... 50 c/s component of the voltage is taken from the ... and R_{47} and applied via the capacitor C_{42} to the input ... the of the variable-phase channel (right triode of ... V_8).

The grid circuit includes the leak resistor R_{55}, the ... circuit the bias resistor R_{54}. The stages of the variable-... employ negative current feedback.

The anode load of the stage is the resistor R_{56}, from ... amplified signal is taken and applied via the capacitor ... circuit consisting of three resistors R_{41}, R_{42} and R_{43}; ...tiometer R_{42} controls the gain of the variable phase ... while resistors R_{41} and R_{43} limit the adjustment of the ...pplied to the grid of the output stage (right triode of ... the top and bottom, respectively. Voltage for the grid of ...t-hand triode of the valve V_9 is taken from the potentio-...ider.

The anode load of the stage is the output transformer Tr_1. ...mary winding of the transformer Tr_1 and the capacitor C_{45} ... resonant circuit tuned to 50 c/s. The secondary winding ... transformer is included in the phase detector circuit. ...istor R_{44} and the capacitor C_{46} form an anode decoupling ...it.

In order to set the balance of the phase detector, the ...ble phase signal must be removed. For this it is necessary ...press the pushbutton "КОНТРОЛЬ" ("CHECK"), the contacts ...ch connect the slider of the potentiometer R_{42} to earth. ...allel with the contact of the pushbutton Pb_2 are connected ...ntacts of the relay P_7. This relay serves for remote switch-...of the variable-phase channel from the control panel for ...rpose of checking the balancing of the circuit during ...ion.

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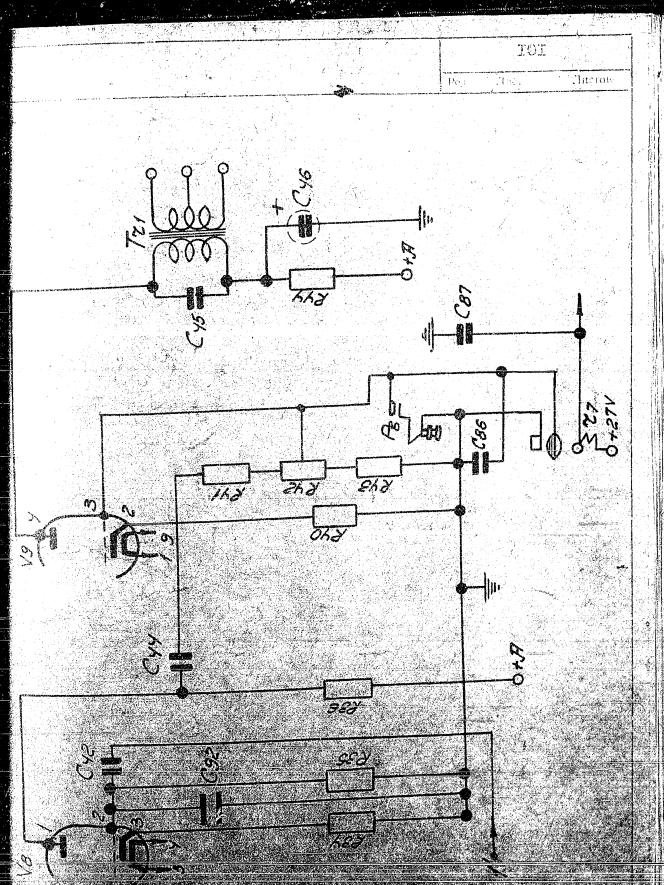

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[illegible] detector

[illegible] detector employs the valve [illegible] (V_{10}). The [illegible] of the variable-phase [illegible] transformer (Tr_1) [illegible] the grids of a double triode (V_{10}, Fig.48)

[illegible] the receiver [illegible] connected the load [illegible] of the constant-phase ampli- [illegible] of the double triode are supplied with voltage [illegible] R_{48} and [illegible] bypassed for [illegible] voltage by the [illegible] C_{52}.

[illegible] the aircraft is flying exactly on the course line, [illegible] receives only the constant-phase signal, which after [illegible] and detection is applied from the anode load of the [illegible] channel amplifier via the secondary winding of the [illegible] Tr_1 to both grids of the double triode with the same [illegible] and phase.

[illegible] both triodes of the valve V_{10} operate under the condi- [illegible] anode detection, the signal applied to their grids increa- [illegible] anode currents of the triodes.

The common cathode current flowing through the resistor [illegible] the series connected winding of the coil of the emergency [illegible] instrument (shunted by the resistor R_{47}) produces a [illegible] voltage which is applied to the valve grids via the resistor [illegible] the secondary winding of the variable phase transformer.

The winding of the coil of the moving coil instrument, type [illegible]-48, which actuates the flap of the emergency signalizer is connected to pins 6 and 3 of the supply connector.

When no signal is applied to the triode grids from the constant-phase channel, the cathode current is low and the emergency signalizer does not operate. When a signal of the order of 10 volts is applied from the constant-phase channel to the grid of valve V_{10}, the cathode current increases and the emergency signalizer operates.

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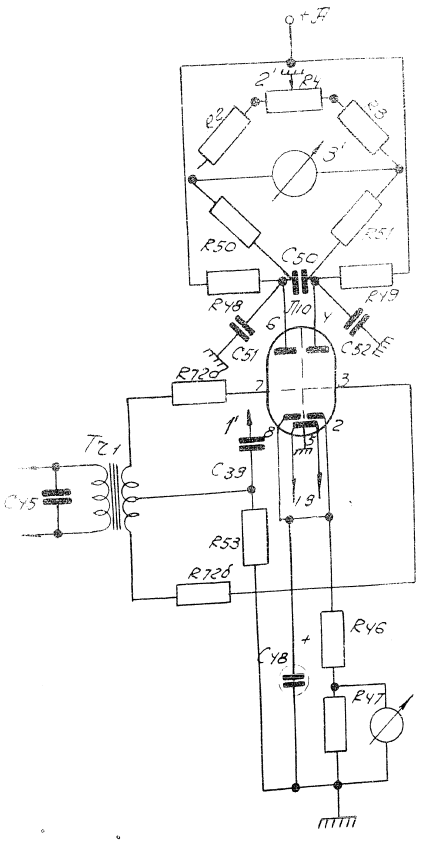

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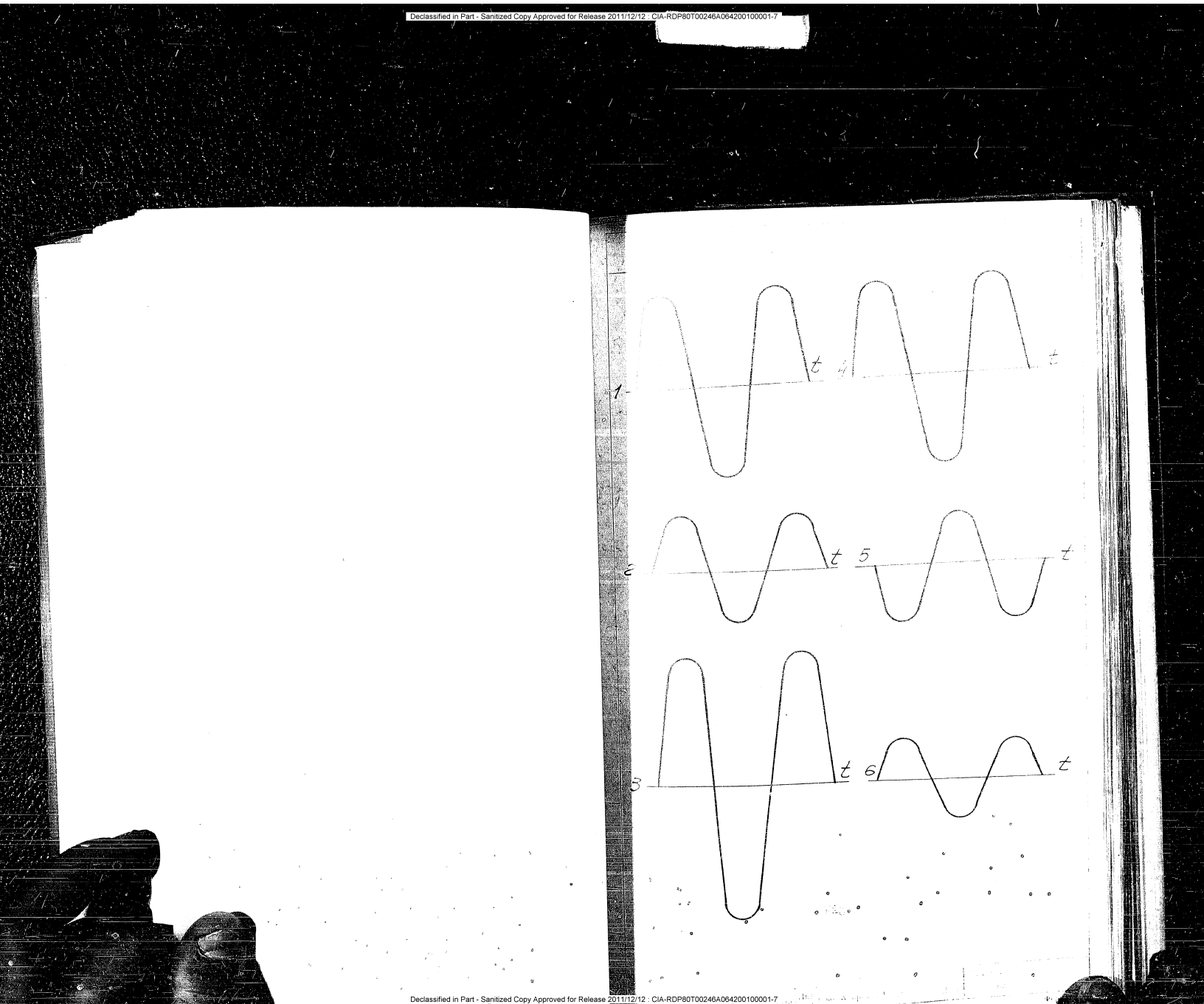

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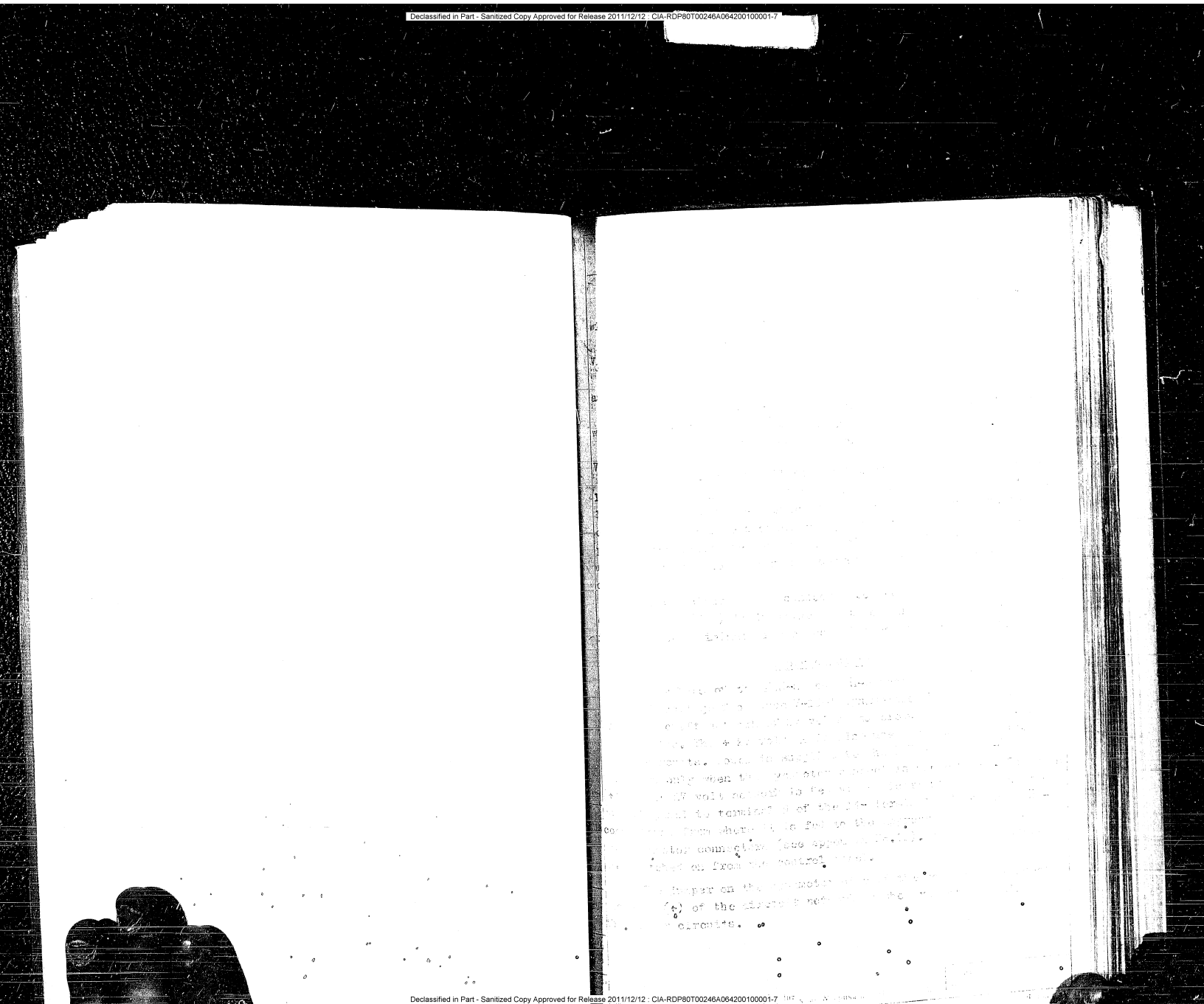

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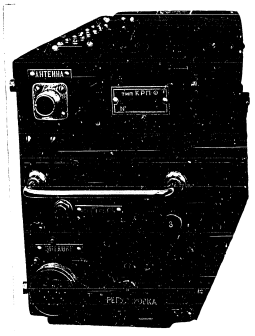

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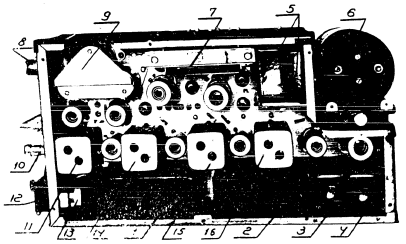

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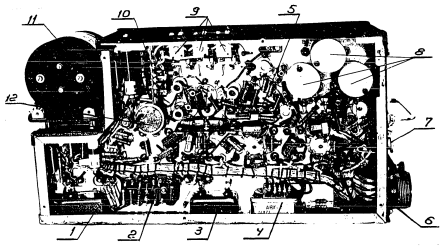

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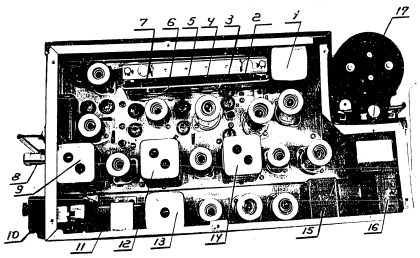

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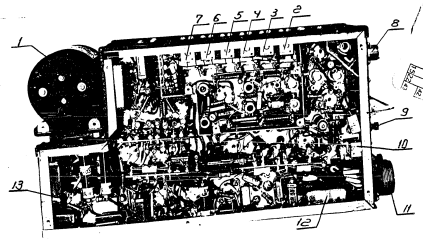

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[illegible]

[illegible] Combination [illegible]

[illegible] of the glide-slope [illegible] for receiving [illegible] [illegible] a single combination [illegible] part of the glide-slope [illegible] tubes arranged [illegible] tubes [illegible] the antenna during [illegible] the reception of [illegible] the rods are soldered in place.

[illegible] part of the [illegible] antenna [illegible] tubes arranged in the horizontal [illegible] the antenna ensures the reception of [illegible] both antennas, the glide-slope and the [illegible] on a stream-line mount. The thicker [illegible] are secured to an insulating plate and [illegible] at the junction. The NPH-1 antenna continues [illegible] line shorted at the end, which serves as a [illegible] (see Fig. 57). This line is screened by a vertical [illegible] having a stream-lined shape, which simultaneously serves [illegible] upright to which both antennas are secured.

The signal received by each of the antennas is fed by [illegible] frequency two-conductor cables to the antenna [illegible] each receiver.

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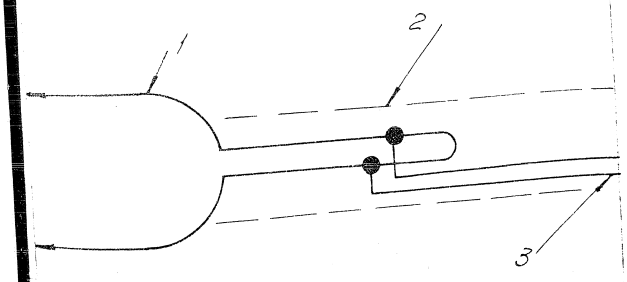

Fig. 57

1. Antenna 2. Screw-upright 3. Feeder

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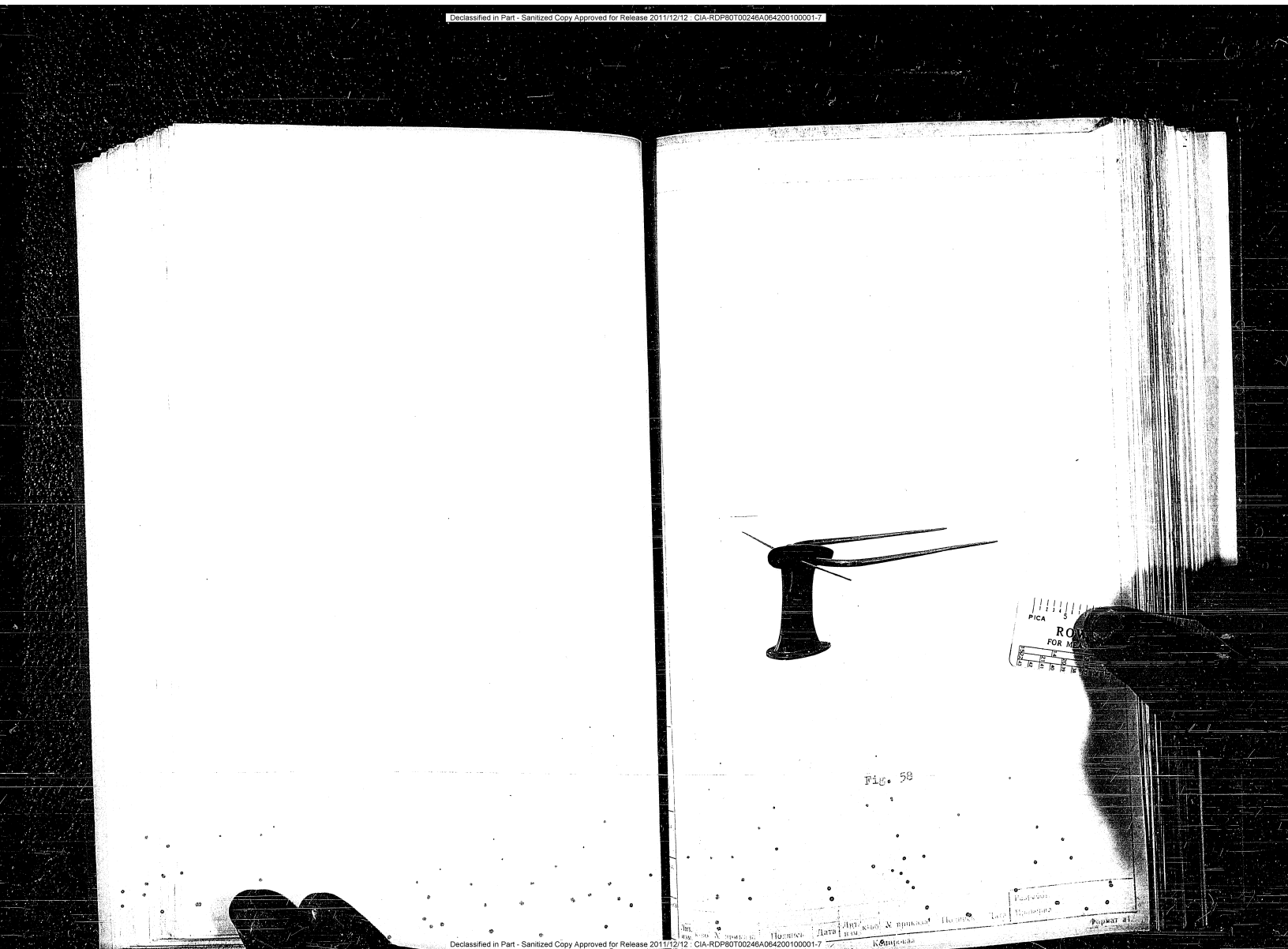

Fig. 58

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[illegible]

[illegible]

[illegible] chassis.

[illegible] between the 8-pin plug [illegible] the sockets of the connector on [illegible] when the dynamotor is removed, [illegible] the valve heaters is broken.

[illegible] circuit and wiring diagrams of the [illegible] 60.

Indicator, Type ИСП-48

[illegible] device, type ИСП-48 is [illegible] moving coil micrometers: two are [illegible] glide-slope) and two are emergency signalizers.

[illegible] meters are housed in a common casing.

[illegible] principle of operation of each of the four [illegible] on the interaction of the field of a permanent magnet [illegible] the current flowing through the coil. A counter [illegible] set up by springs. The electrical circuit of the indicator is shown in Fig. 60.

Each system of the indicator consists of a movable and a stationary part.

The movable part of the course and glide-slope [illegible] consists, in the main, of a coil and the pointer which is rigidly secured to it.

The movable part of the emergency signalizers consists of a coil with a flap secured to it. The stationary part of each system consists of a permanent magnet with pole pieces and a core.

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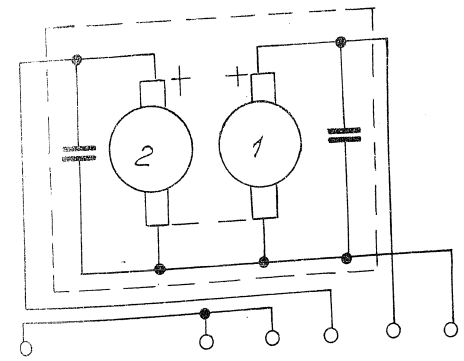

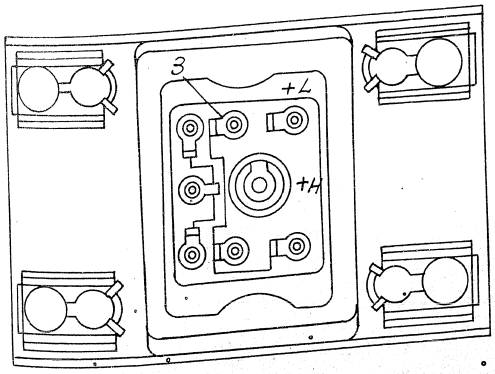

Фиг. 59.

1. НУ 2. НУ 3. Сопло

Разраб.

Провери

Инв. № подл. | Подпись | Дата | Взам. инв. № | Инв. № дубл. | Подпись | Дата | Копировал | Формат

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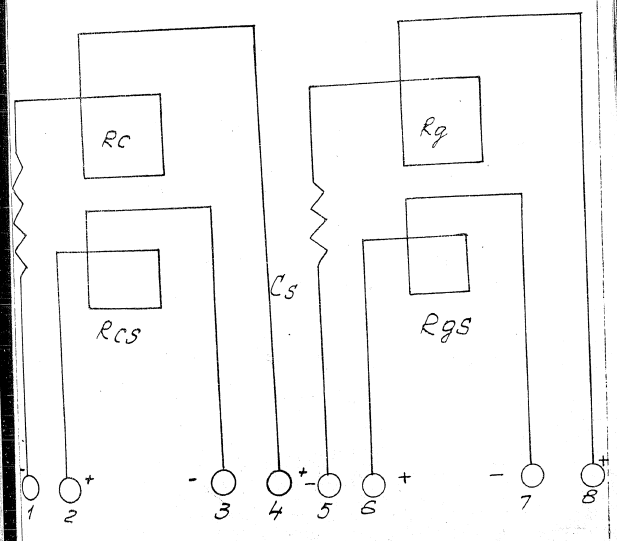

Fig. 60

R_c – Course indicator coil;
R_g – Glide-slope indicator coil;
R_{cs} – Course signalizer coil;
C_s – Series resistor coils;
R_{gs} – Glide-slope signalizer coil

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[illegible] and the role pieces of [illegible] [illegible] of the course and glide-slope [illegible] [illegible] a cylindrical shape. The [illegible] [illegible] have a cylindrical shape with [illegible] [illegible] [illegible] in the working [illegible] [illegible] pointer serves as the [illegible] [illegible] as the glide-slope [illegible] [illegible] signalizers, painted [illegible] [illegible] above the course and glide-slope [illegible]

[illegible] full scale deflection current of [illegible] [illegible] is 200 to 300 mA. The full hole [illegible] [illegible] signalizers is 450 to 600 [illegible]

[illegible] resistance of the course or glide-[illegible] [illegible] ± [illegible]. The resistance of the [illegible] [illegible] ± [illegible].

[illegible] general view of the [illegible] [illegible]

Control panel

[illegible] control panel is housed in a cabinet [illegible] [illegible] box with a detachable [illegible] [illegible] of the cabinet are arranged: frequency [illegible] [illegible] "[illegible]" ("[illegible]") and the pushbutton [illegible] [illegible]). On the side wall is [illegible] connector.

[illegible] control panel is designed for remote [illegible] of the radio receivers and for remote switching of [illegible] frequencies, as well as for checking and setting [illegible] of the [illegible] receiver.

The general view and the circuit-wiring diagram of the control panel are shown in Figs. 62 and 63. The control [illegible] is connected to the receivers and the distribution box [illegible] [illegible] diagram of cable connections (see appendixes [illegible]).

Distribution box

The distribution box serves for electrical interconnection [illegible] units of the aircraft blind-landing equipment [illegible]

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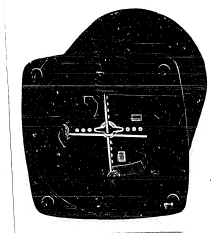

Fig. 61

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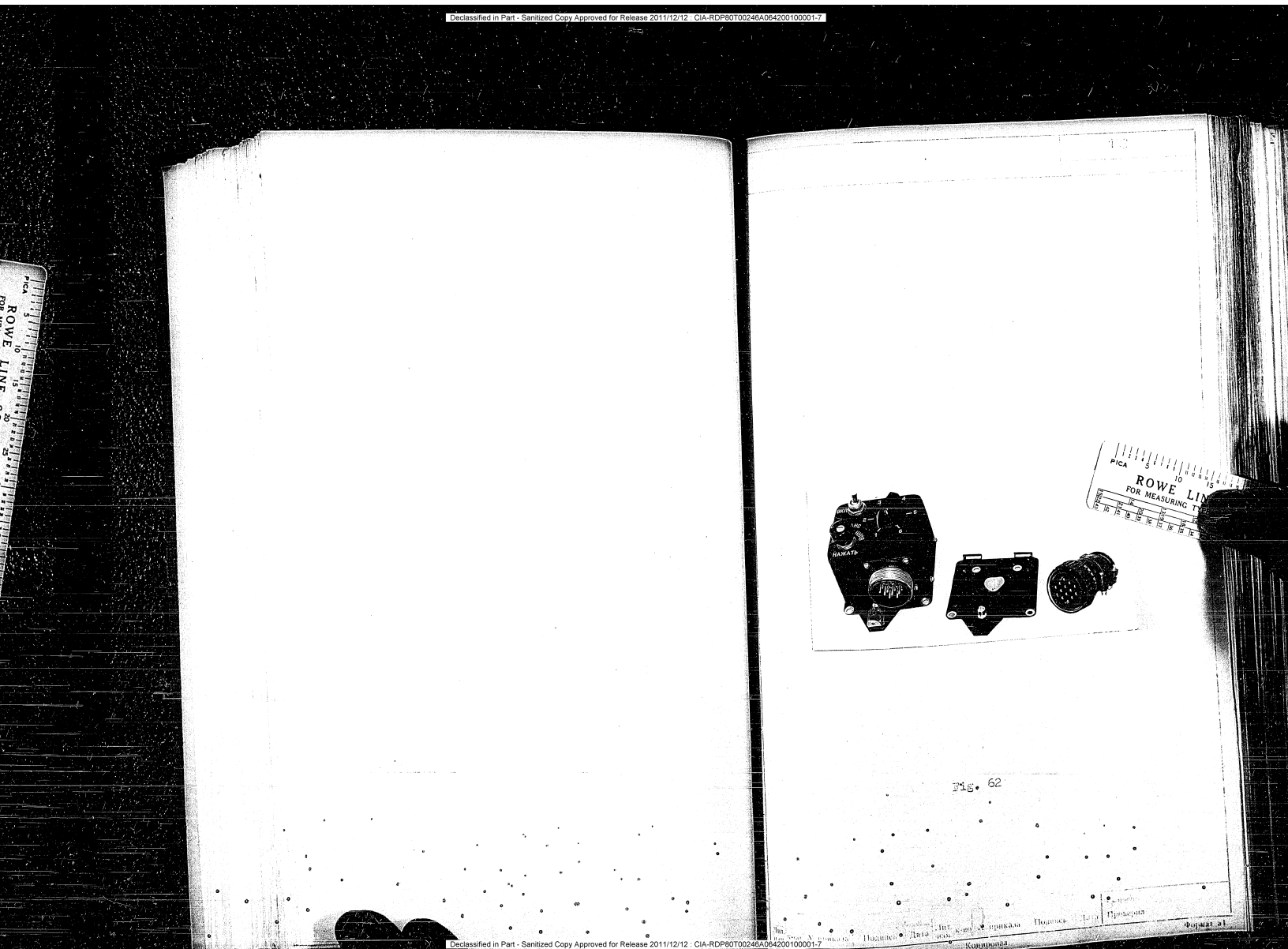

Fig. 62

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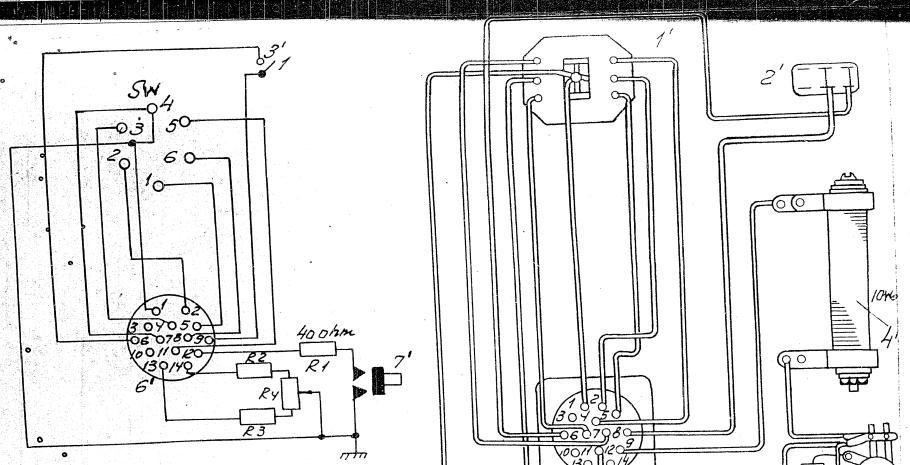

Fig. 6)
1'. 6-way switch 2'. Switch 3'. Sw_1 4'. 40 ohms
5'. 25K-ohms 6'. Connector 7'. [illegible]

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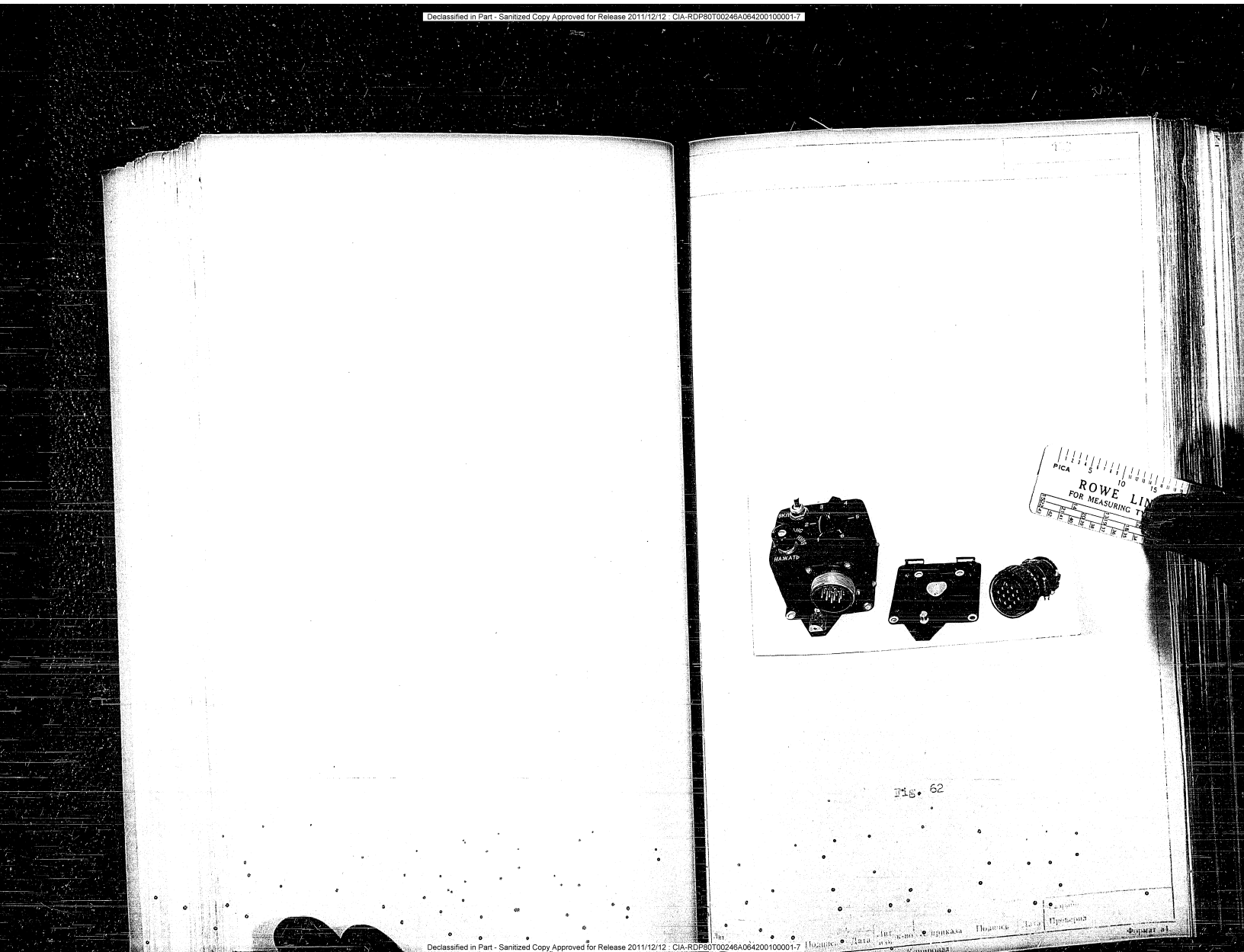

Fig. 62

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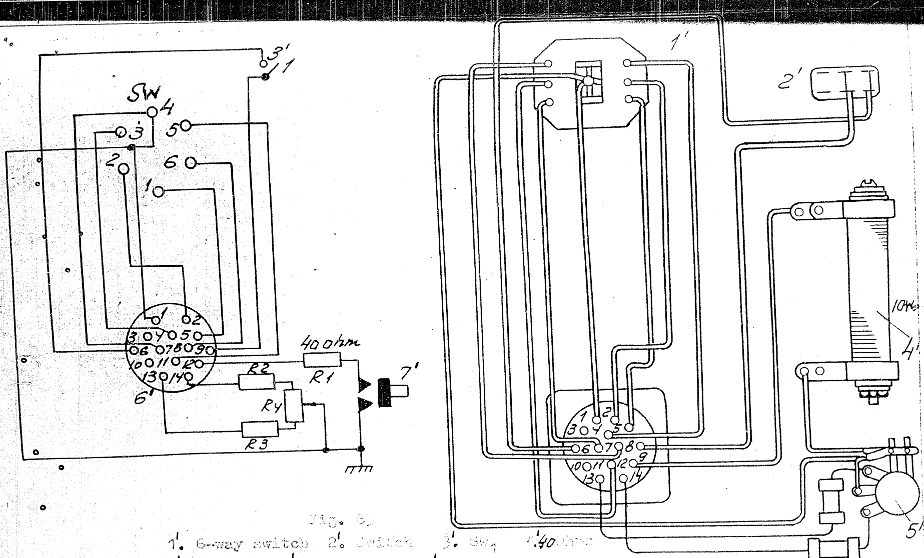

Fig. 6.

1'. 6-way switch 2'. Switch 3'. Sw1 4'. 40 ohms
5'. 15K-ohms 6'. Connector 7'. Pl.

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[illegible] aircraft [illegible] units.

[illegible] view of the box is shown [illegible] 64.

[illegible] approached [illegible] from the aircraft network, [illegible] receivers, [illegible] and [illegible]-48indicator. When [illegible] the [illegible] system [illegible] is also approached by [illegible] applied [illegible] and the capacitors unit. [illegible] in the supply circuits of [illegible] receivers.

Shock absorber frame

[illegible] receivers are mounted on shock-[illegible] frame.

[illegible] frame is shown in Fig. 65. Two lateral [illegible] holes for rigid fastening by bolts to the aircraft [illegible] at the front and rear ends of the frame with [illegible] four rubber shock absorbers.

[illegible] receiver is mounted on a frame, the projecting [illegible] receiver body engages a clasp at the rear end of [illegible] the receiver is secured with the aid of a screw [illegible] a carriage at the front end of the frame. This [illegible] provides an electrical contact between the receiver [illegible] the frame. The frame, in its turn, is connected by [illegible] conductors to the lateral strips, from which flexible [illegible] are connected to the aircraft body with the aid of special [illegible] bolts.

[illegible] shock absorbtion of the receiver is provided during [illegible] of the aircraft and an electrical contact between the [illegible] and the aircraft body.

[illegible] INSTRUCTIONS ON INSTALLING AND OPERATING THE ГРН-2, КРН-4 AND AN [illegible] EQUIPMENTS

Installation of the equipment

The ГРН-2 and КРН-4 receivers and the amplitude attach-[illegible] are remotely controlled, which allows the equipment to be [illegible] in the most convenient place.

[illegible] M-50 control panel, the switch "СП-50-ИМС" and the

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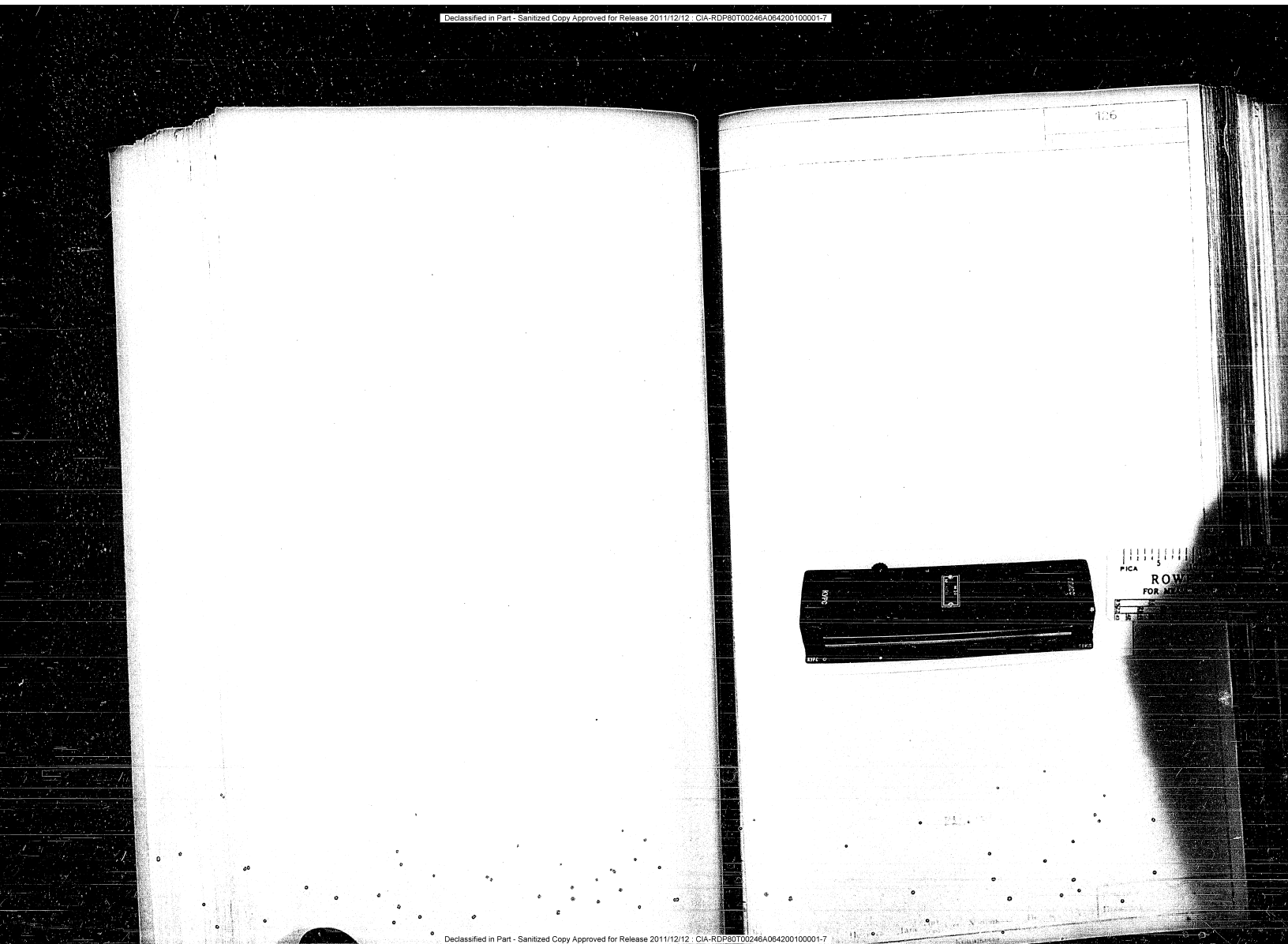

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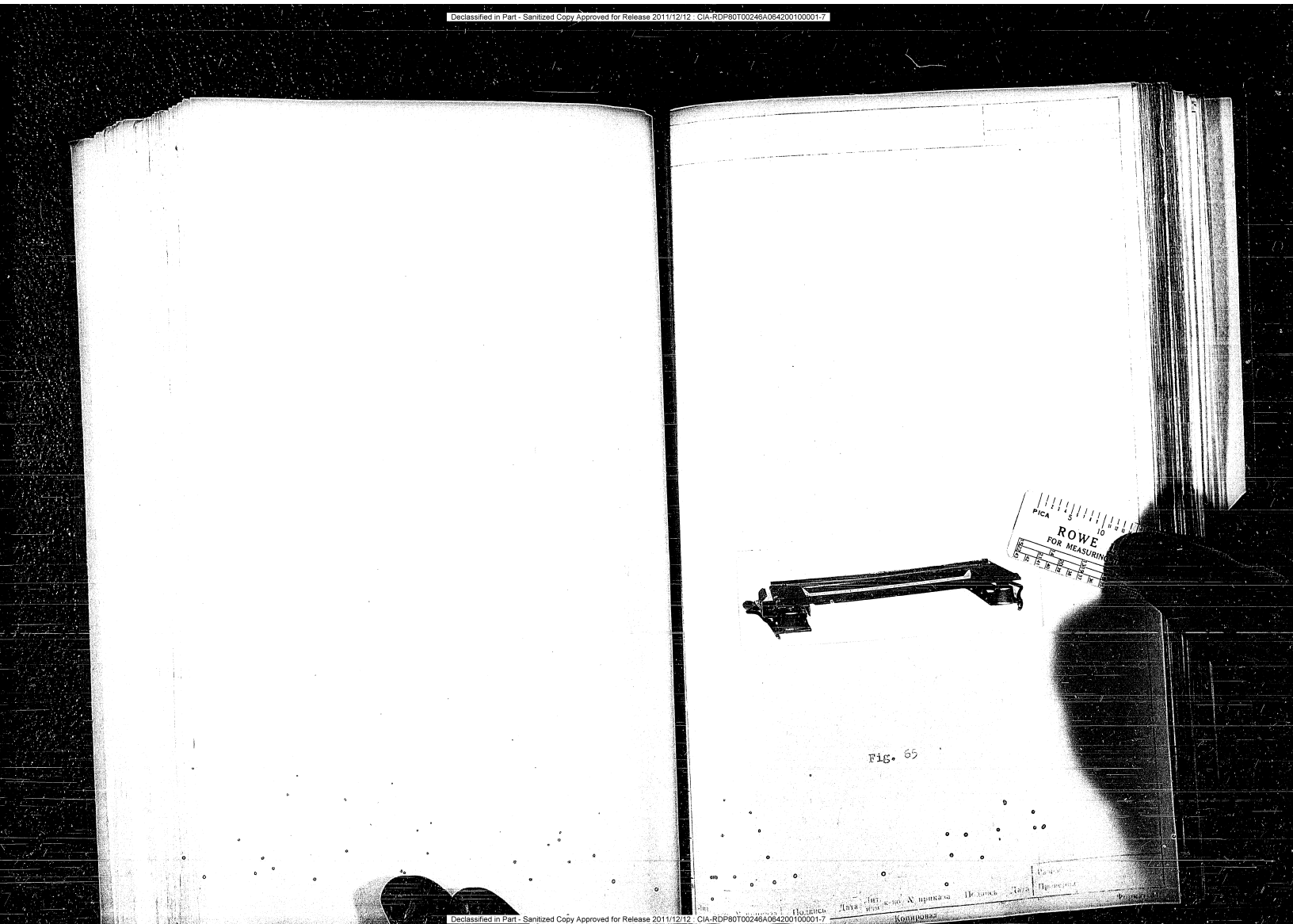

Fig. 65

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[illegible] should be set up in the immediate vicinity [illegible]

[illegible] connector of the amplitude attachment [illegible] attachment, or to the aircraft body in [illegible] of the amplitude attachment, and in a [illegible] for screwing in the [illegible]

[illegible] the [illegible] and [illegible] amplitude attach- [illegible] on the aircraft, the strip on the front [illegible] "РЕГУЛЯРОВКА" [illegible] not unscrewed, and the potentiometers on the [illegible] are not adjusted.

[illegible] are made during checkups of the [illegible], [illegible] attachment by the appropriate technical [illegible]

[illegible] frame should be secured rigidly in the [illegible] above, the selected place [illegible] ready access for screwing in plugs, mounting and [illegible] and should also ensure convenient arrange- [illegible] of the cables.

The [illegible], [illegible] and amplitude-attachment equipments [illegible] to the frames with the aid of a screw at the front [illegible] the frame. A dimensional drawing of the [illegible]-receiver [illegible] and a drawing giving the marking of the installation [illegible] shown in Figs. 66 and 67.

[illegible] receiver has the same dimensions.

[illegible] reliable electrical contact between the shock absorber [illegible] and the aircraft body is provided by the flexible conductors [illegible]

The control panel should be installed in such a way that [illegible] could readily manipulate the controls arranged on the [illegible]. In addition, the selected site should ensure ready [illegible] for installing the removing the panel, screwing in plugs, [illegible] should also ensure convenient arrangement of the cables.

The panel brace is secured in the selected site, and the [illegible] secured to the base with the aid of latches.

The distribution box. When installing the distribution [illegible] site is selected so that the length of the cables and

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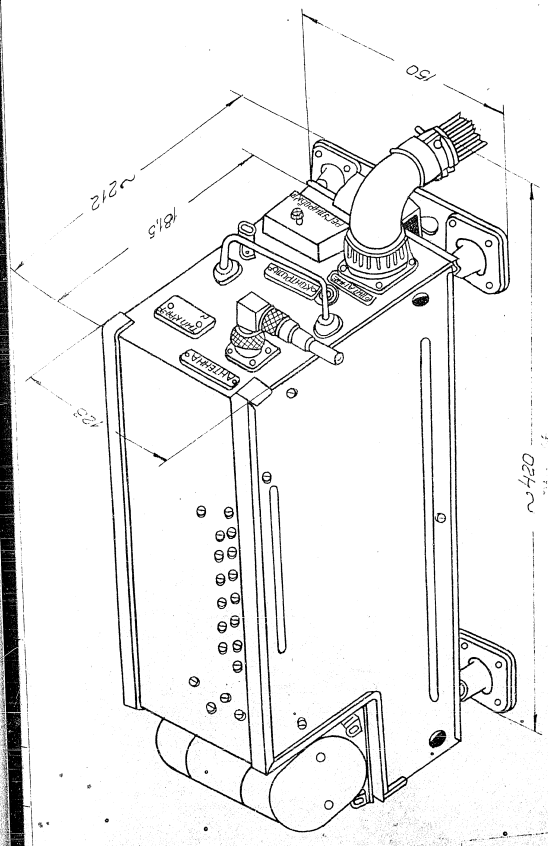

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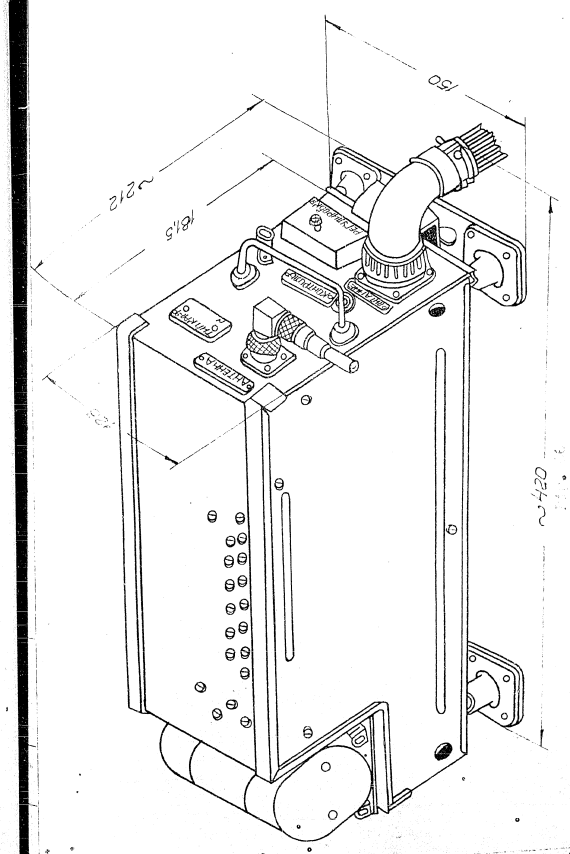

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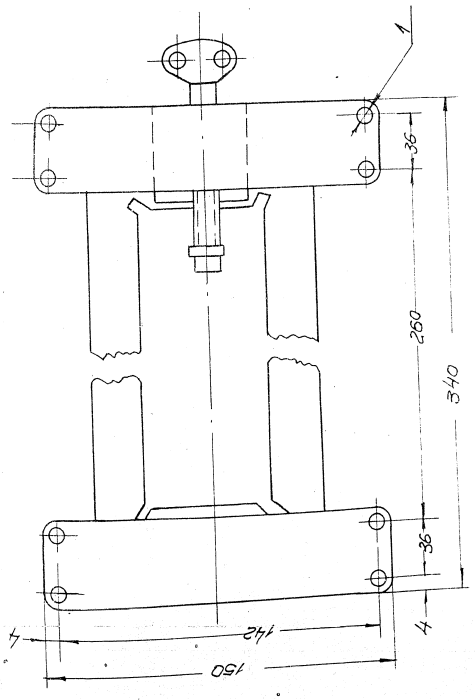

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[illegible] is to be installed in [illegible], i.e. in parallel [illegible] should [illegible] necessary to [illegible] over [illegible]

[illegible] manufactured [illegible] to [illegible] the [illegible] circuit [illegible] the circuit [illegible] to [illegible] ohms.

[illegible] the [illegible] attachment is located in the [illegible] of the [illegible].

[illegible] checking

[illegible] in the aircraft [illegible] of the [illegible] therefore [illegible] of the equipment [illegible] before each flight [illegible] receivers in the [illegible] indicators, types [illegible] indicators type "[illegible]" [illegible] operation [illegible] are carried out according to the operating instructions of the [illegible]tor.

[illegible] the ГРП-2 and КРП-2 [illegible] "[illegible]" [illegible]

[illegible]-flight checking of the blind landing equipment in the [illegible] is carried out in the following order:

1. Check all the connections and make sure that all the [illegible] are connected correctly.

2. Check the voltage of the aircraft network. If the [illegible] has a voltage of less than 25 v or more than 30 v, the ГРП-2 and КРП-2 receivers must not be operated.

3. Check the switching-on of the ГРП-2 and КРП-2 receivers with the aid of the "[illegible]" ("[illegible]") toggle switch on the control panel (the dynamotors should turn).

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Копировал

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Note : Articles 1, 2, 3 are common for both [illegible] and "КАС" systems.

[illegible] the electrical [illegible] and [illegible] receivers.

For checking the КРМ-[illegible] it is necessary to:

[illegible] the required crystal [illegible] on the [illegible]-50 control panel.

[illegible] Set up the КНРМ-[illegible] imitator at a distance [illegible] from the aircraft and switch it on. Set the switch "[illegible]" - "[illegible]" ("COURSE - AZIMUTH") of the imitator [illegible] "[illegible]" [illegible]. Set the switch "КОНТРОЛЬ [illegible]" - "[illegible]" ("[illegible]" - "OPERATION") in the position "[illegible]" [illegible] of operation switch in the position "[illegible]").

[illegible] In the control panel, depress the pushbutton "[illegible]" ("[illegible] CHECKING"), in this case the indicator [illegible] stop opposite the vertical line of [illegible] has been disturbed, it is necessary to set the [illegible] with the aid of the potentiometer "[illegible]" ([illegible]) located on the [illegible]-50 control panel.

[illegible] By turning the knob of the imitator [illegible] right, obtain deflection of the НСП-48 [illegible] the edge of the coloured sector, i.e. [illegible] scale of the НСП-48 indicator. If [illegible] pointer deflects more or less, the [illegible] "[illegible]" ([illegible]) on the front panel of the [illegible] be opened, the lock nut of the sensitivity [illegible] and its shaft turned to set the pointer [illegible] scale. After adjustment it is necessary to [illegible] turning of the imitator knob to left and right [illegible] pointer to deflect to left and right, respectively. [illegible] the pushbutton "КОНТРОЛЬ КУРМ" ("[illegible]") [illegible] control panel is depressed, the pointer of the course [illegible] stops exactly opposite the vertical of [illegible] scale of the НСП-48 indicator.

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[illegible]

[illegible] of operation [illegible] "[illegible]" ([illegible]), in this case the [illegible] of the glide-slope indicator should be closed by the [illegible], the indicator pointer should [illegible] the [illegible] position. [illegible] balance of the receiver to [illegible] (the glide-[illegible] indicator pointer does not set in the [illegible]), [illegible] to uncover the screw securing the lid [illegible] "[illegible]" ([illegible]) on the front panel of the [illegible], having released the stop [illegible] "[illegible]" ([illegible]), [illegible] of [illegible], in the position corresponding to [illegible] of the glide-slope indicator pointer. After adjustment, the [illegible] "[illegible]" should be shut. This type of adjustment should be carried out by skilled technical personnel.

[illegible] for checking the sensitivity of the [illegible] receiver, [illegible] the commutations indicated in paragraph "i", in this case the glide-slope pointer of the indicator should set to the [illegible] upper dot of the vertical scale and the emergency signalizer window should be closed by a black flap.

[illegible] Repeat the commutations indicated in paragraph "j". In this case the glide-slope pointer of the indicator should set to the 1st-3rd lower dot of the vertical scale and the emergency signalizer window should be shut by a black flap.

[illegible] If the indicator pointer does not set within the indicated limits, the screw securing the lid "ADJUSTMENT" on the front panel of the receiver should be unscrewed, the stop nut released and the potentiometer "ЧУВСТВИТЕЛЬНОСТЬ" ("[illegible]") set in such a position that the glide-slope pointer of the indicator would set to the 1st-3rd dot up or

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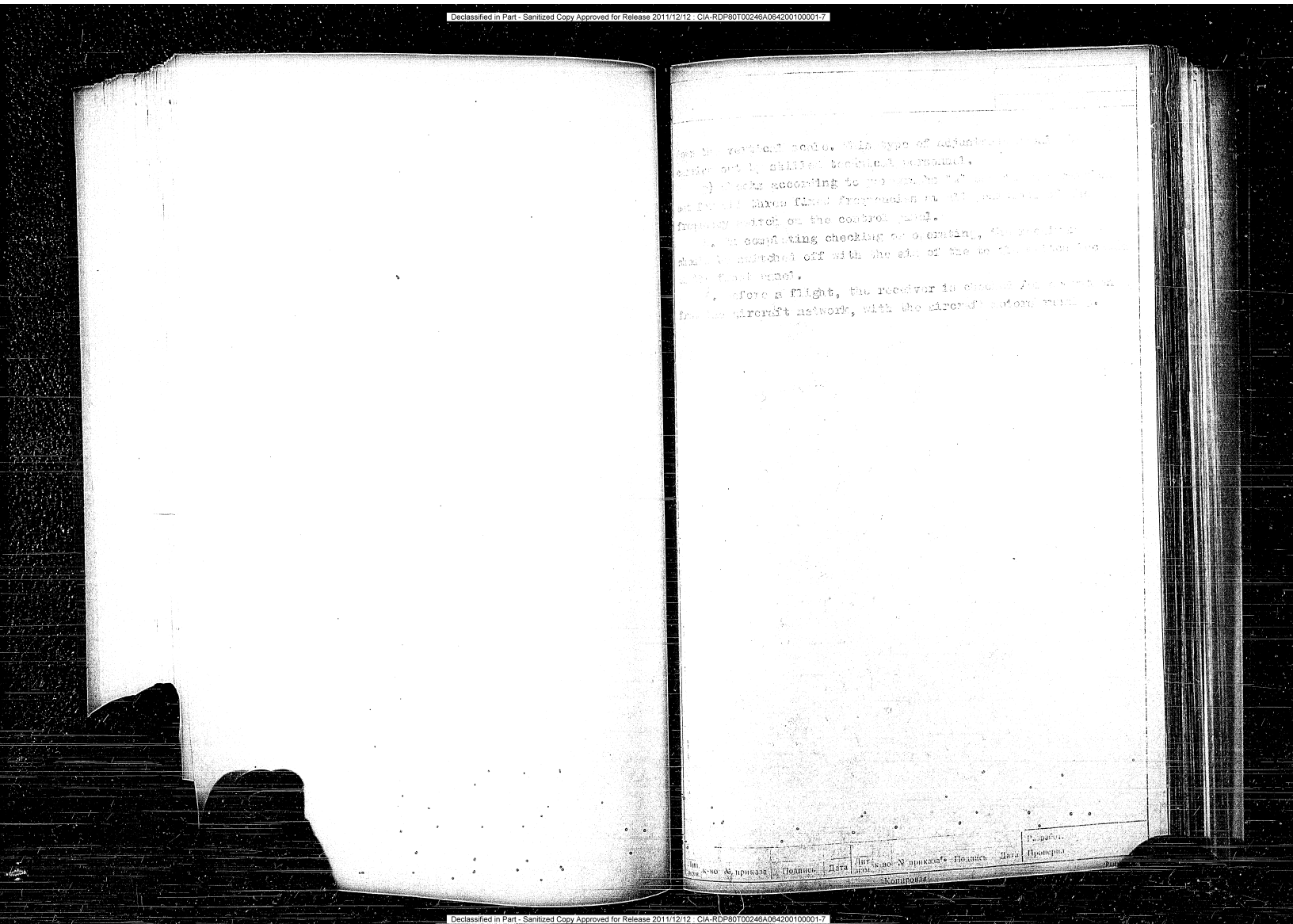

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Checking the КРП-ф and ГРП-2 receivers with the amplitude attachment in the "ИЛС" (ILS) system

Check according to paragraphs 1,2,3 as was indicated for the "СП-50" system (page 132).

a) The site of installation, preparation for operation and operation with the "ИЛС" imitator are carried out according to the operating instructions of the "ИЛС" imitator.

b) Set the switch "СП-50" - "ИЛС" in the position "ИЛС"

c) Set the switch on the V-50 control panel in the position "ВКЛ" ("ON").

d) Set the crystal switch on the control panel in the position "В".

Note: 1. Those КРП-ф and ГРП-2 receivers are operated with amplitude attachments, the circuits of which have been modified according to the instructions given in appendices Nos. 17, 18, 19, 20.

2. Under normal conditions, modified ГРП-2 receivers should have a sensitivity of not worse than 125 MV and are operated with capacitors units in both the "СП-50" and "ИЛС" systems.

1. Checking the КРП-ф receiver

a) Set the depth of modulation of the "ИЛС" imitator to 20% for the frequency 90 c/s and to 20% for the frequency 150 c/s. With the aid of the potentiometer "БАЛАНС "0" ("ZERO BALANCE") of the amplitude attachment, set the course pointer of the ПСП-48 indicator to the vertical line of dots on the scale.

b) Set the depth of modulation of the "ИЛС" imitator to 25% for the frequency 90 c/s and 16% for the frequency 150 c/s. With the aid of the potentiometer "ЧУВСТВ " ("SENSITIVITY") of the amplitude attachment set the pointer of the course indicator to the right by 2-3 dots of the horizontal scale of the ПСП-48 indicator.

c) Set the depth of modulation of the "ИЛС" imitator to 16% for the frequency 90 c/s and to 25% for the frequency 150 c/s.

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...the pointer of the ... [illegible]

...symmetrical deflection ... [illegible]

...position of the ... [illegible]

...onto

...4 ("10 - 0") of the ... [illegible]

...of the pointer of the ... [illegible]

...Set the depth of modulation of the "AM" indicator to ... frequency 30 c/s and to 50% for the frequency 400 c/s.

...the pointer of the glide-slope indicator of the ... equipment should deflect up to within the limits of the ... the stop of the [illegible]-48 scale.

Note: Asymmetrical deflection of the pointer of the [illegible]-10 ... in one direction or the other is permissible. In this ... medium sensitivity is selected when the pointer of the

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ПС-45 indicator may deflect beyond the 4th dot in one direction and less in the other direction.

5) The operation of the РСП-2 receiver on all fixed frequencies is carried out according to the operating instructions of the "АСС" imitator. The operational ability of the receiver is determined by the deflection of the glide-slope indicator of the ПСП-48 equipment.

The РПП-2 receiver should operate normally with the switch in the positions indicated in Table No.4

OPERATING THE РПП-2 AND КРП-Ф RECEIVER DURING FLIGHTS

The main rule when using the КРП-Ф receiver in the "СП-50" system when piloting an aircraft according to the working course zone is the following: when flying the landing course to the beacon, the vertical pointer of the indicator deflects in the opposite direction to that of the aircraft, i.e. when the aircraft deflects to the right, the pointer deflects to the left, and when the aircraft deflects to the left, the pointer deflects to the right. (Fig.68).

When flying in the opposite direction to the landing course, the vertical pointer of the indicator deflects in the same direction as the deflection of the aircraft from the zone, i.e. when the aircraft deflects to the right, the pointer deflects to the right, and when the aircraft deflects to the left, the pointer deflects to the left. In other words when flying down the landing course, the pointer always indicates the direction in which the aircraft should be turned to enter the zone. When flying in the opposite direction to the landing course, the pointer indicates in which direction the aircraft has deflected from the zone.

If the aircraft is located in the "yellow" part of space and turns through 360°, then the indicator pointer will continuously deflect in the same direction. If the aircraft is located in the "blue" part of the space, then irrespective of the position of the aircraft, the indicator pointer will continue to deflect point

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in the other direction (see Fig.68). From this it follows that the [illegible] receiver cannot be used as a radio compass.

When the aircraft passes from the "yellow" part of space into the "blue" part of space, at the moment of passage through a sector of the zone which is about 2,5° wide, the indicator point passes smoothly from one extreme position to another, i.e., the course indicator can be used for pilotting the aircraft for landing with an accuracy within a sector 2,5° wide.

The zero position of the indicator pointer on the border between the "blue" and "yellow" parts of space corresponds to location of the aircraft exactly on the course line. To the right of the vertical pointer on the front panel of the [illegible]-48 indicator [illegible], is an emergency signalizer window which is covered by a flap coated with a white fluorescent compound (if the receiver is not operating, or there is no signal from the beacon). When the aircraft is within the radiation zone of the radio beacon and the field strength is sufficient, the white part of the signalizer flap turns and is replaced by the black part which blends with the colour of the indicator panel.

When the aircraft enters the course zone, the vertical pointer of the indicator moves to the zero position.

The emergency signalizer window, covered by a black flap, indicates that the transmitting-receiving assemblies are in order. In all other cases: failure of the course beacon or radio receiver, or low field strength (less than is required for normal operation of the receiver)- the window is covered by a white flap.

The appearance of the white flap indicates that the system has failed and cannot be used.

During flights, on entering the radius of operation of the beacon, it is recommended to depress the pushbutton "КОНТРОЛЬ НУЛЯ" ("ZERO CHECKING") on the control panel to check the balance setting. In this case the pointer of the course indicator should be located in the middle of the black disk. If required, set the balance by depressing and turning the pushbutton "КОНТРОЛЬ НУЛЯ" ("ZERO CHECKING").

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The rule for using the ГРП-2 receiver when landing an aircraft by the "СП-50" system is the following: when flying towards the beacon, the pointer of the glide-slope indicator (horizontal pointer of the ПСП-48 indicator) deflects up when the aircraft deflects down from the glide-slope line, and deflects down when the aircraft deflects up. When the aircraft deflects from the glide-slope line by an angle 0.25° the pointer crosses smoothly from the middle position to the extreme bottom or top position, i.e. the glide-slope indicator can be used for piloting the aircraft or landing with an accuracy within a sector having an angular width of 0.5°. When using the ПСП-48 indicator, it is necessary to pay attention to the flap of the emergency signalizer. If when piloting an aircraft for landing a white flap appears alongside the pointer the system has failed and can no longer be used.

Note: When operating in the "ILS" system, the rules for operating the ГРП-2 and КРП-ф radio receivers are the same as for the "СП-50" system.

CHECKING THE MAIN PARAMETERS OF THE ГРП-2, КРП-ф AND АП EQUIPMENT

Checking the main parameters of the ГРП-2 receiver

Among the main parameters of the radio receiver are sensitivity, intermediate frequency bandwidth and A.G.C. characteristics.

The main parameters are measured during periodic check ups, at the end of the guarantee term, after repairs and replacement of valves. These measurements should be made at an appropriately equipped workshop or laboratory by skilled technical personnel. For measuring, it is necessary to have a workbench equipped according to the block diagram showing the interconnection of the equipment for measuring the main parameters of the radio receiver (Fig.69).

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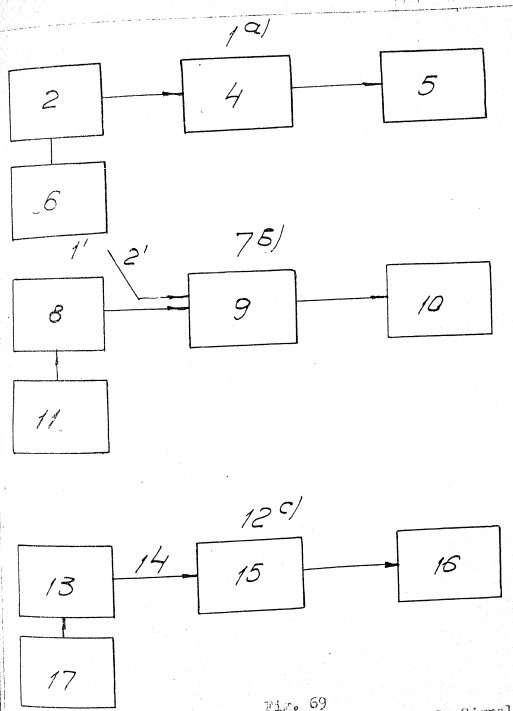

Fig. 69

1. a) Block diagram for measuring sensitivity 2. Signal generator, type PCK-2 3. To input 4. PPM-2 receiver 5. output indicator 6. Audio generator type 3G-2A 7. b) Block diagram for measuring bandwidth of intermediate frequency amplifier. 1) Via capacitor of 100-200 pF to coaxial tuned circuit L_2 C_2 2) Via capacitor to 1st pin of valve V_2 8. standard signal generator PCC-6 9. PPM-2 receiver 10. CRO 11. Audio generator type 3G-2A 12. c) Block diagram for measuring A.G.C. 13. Signal generator type PCK-2 14. To input 15. PPM-2 receiver 16. D.C. microammeter with scale of 1000-0-1000 mcA 17. Audio generator type 3G-2A.

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While measuring it is necessary to check the mains voltage and the current drawn by the radio receiver.

The following instruments are required:

- [illegible] beacon signal [illegible], type [illegible]-2;
- standard signal generator, type [illegible];
- [illegible] frequency generator, types [illegible] or [illegible];
- u.h.f. generator, type [illegible];
- [illegible] voltmeter for 30 volts;
- [illegible] ammeter for 5 amperes;
- [illegible] ammeter for 1000-0-1000 [illegible].

The rules for operating the above instruments are listed in the instructions of the instruments.

Measuring sensitivity.

Switch the receiver on. Connect the output of the u.h.f. generator to the antenna input of the receiver. Apply a voltage [illegible] frequency of 90 or 150 c/s from the audio generator to the u.h.f. generator. Set the modulation factor to 30%. According to the [illegible] deflection of the indicator pointer set the frequency of the u.h.f. generator equal to the working frequency of the receiver. The sensitivity is determined by the magnitude of the generator output signal (with allowance for the calibration curve) required for deflecting the indicator pointer by 2 dots. The sensitivity should not be worse than 250 MV when operating with one indicator and not worse than 300 MV when operating with two indicators. Sensitivity is checked on all working frequencies of the receiver.

Note: 1. If a ГСК-2 generator is not available, an [illegible] generator can be used.

2. If a u.h.f. generator is not available, sensitivity can be evaluated approximately with the aid of the ГИТМ-2 imitator.

Measuring the bandwidth of the intermediate frequency amplifier

The intermediate frequency bandwidth of the receiver is

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determined with the aid of a standard signal generator, ГСС-6. The bandwidth is measured at levels of 0.5, 0.1, and 0.01 of the resonance value. When measuring the bandwidth at a level of 0.5 of the resonance value, voltage is applied from the standard signal generator, type ГСС-6, via a capacitor of 100 to 200 pF to the coil L_2 with respect to the receiver chassis.

The output voltage of the standard signal generator is modulated by a frequency of 90 or 150 c/s to a depth of 0.5 and set to such a value that the glide-slope pointer of the indicator deflects by the full working angle.

The bandwidth is measured at the 0.5 level with the output voltage of the standard signal generator doubled. In this case the sum of the detuning of the standard signal generator frequency is determined, which is required to obtain full working angle deflection of the indicator pointer.

Measuring of the bandwidth at the 0.1 and 0.01 levels is carried out in a similar way, with the output voltage of the standard signal generator increased 10 and 100 times, respectively, the only difference being that the signal voltage is applied via a capacitor of 100 to 200 pF to the mixer grid (V_2).

Note: When measuring the bandwidth of the receiver after repairs, as well as when re-tuning the intermediate frequency, it is necessary with the aid of a crystal calibrator to set the intermediate frequency of the receiver exactly on the dial of the standard signal generator. When measuring the bandwidth on the 0.5 level, make sure that the frequency is in the middle of the passband. The permissible asymmetry of the resonance curve with respect to the intermediate frequency is ±100 Kc/s.

CHECKING THE A.G.C.

A signal from a type ГСК-6 generator, modulated by a voltage having a frequency of 90 or 150 c/s is applied to the receiver input. A microammeter having a scale of 1000-0-1000, the

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internal resistance of which should not exceed 200 ohms, is connected in series with the indicator. Tuning the generator to one of the [illegible] frequencies, obtain maximum indicator current. With the input signal set to 500 MV (with allowance for the calibration curve), the first reading is noted. Then the signal of the generator is increased to 1[illegible],000 MV and the generator tuned [illegible] maximum indicator current. Now the next reading is made.

The quotient of the first reading divided by the second gives the value of the A.G.C. coefficient. The A.G.C. coefficient should not exceed 1 ±20%.

Checking the main parameters of the КВП-4 receiver

The following parameters should be checked: sensitivity, intermediate frequency bandwidth, operation of the A.G.C., and the discriminator characteristic. A block diagram for connecting the measuring instruments is shown in Fig.70.

Measuring sensitivity.

The sensitivity of the receiver is checked on all six fixed frequencies, with the r.f. signal modulated to a depth of 30% by a voltage having a frequency of 60 c/s, with the gain of the variable-phase channel at maximum, i.e. the shaft of the potentiometer "ЧУВСТВИТ. "("SENSITIVITY") turned fully clockwise.

The radio frequency voltage from the СГ-1 (or similar) generator, modulated from the ЗГ-2А audio frequency generator is applied to the receiver input. The sensitivity of the receiver is determined by the output voltage of the СГ-1 generator in microvolts (with allowance for the calibration curve) when the signal voltage at the phase-detector grid is equal to 1 v, which is measured with the aid of an ИВ-4 instrument. At the same time the constant-phase channel should be shorted to earth (pin 2 or 7 of the valve V_6). The measured sensitivity should not be worse than 20 MV on all six fixed frequencies. The measurements are made with the supply voltage of the receiver equal to 27 volts.

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matching resistance of which should not exceed 200 ohms, is connected in series with the indicator. Tuning the generator to one of the working frequencies, obtain maximum indicator current. With the signal set to 500 MV (with allowance for the calibration curve), the first reading is noted. Then the signal of the generator is increased to 1,000 MV and the generator tuning for maximum indicator current. Now the next reading is made.

The quotient of the first reading divided by the second gives the value of the A.G.C. coefficient. The A.G.C. coefficient should not exceed 1 ±20%.

Checking the main parameters of the УКВ-Ф receiver

The following parameters should be checked: sensitivity, dependence on frequency bandwidth, operation of the A.G.C., and the discriminator characteristic. A block diagram for connecting the measuring instruments is shown in Fig.70.

Measuring sensitivity.

The sensitivity of the receiver is checked on all six fixed frequencies, with the r.f. signal modulated to a depth of 30% by a voltage having a frequency of 60 c/s, with the gain of the variable-phase channel at maximum, i.e. the shaft of the potentiometer "ЧУВСТВИТ. "("SENSITIVITY") turned fully clockwise.

The radio frequency voltage from the СГ-1 (or similar) generator, modulated from the Г-34 audio frequency generator is applied to the receiver input. The sensitivity of the receiver is determined by the output voltage of the СГ-1 generator in microvolts (with allowance for the calibration curve) when the signal voltage at the phase-detector grid is equal to 1 v, which is measured with the aid of an ИВ-4 instrument. At the same time the constant-phase channel should be shorted to earth (pin 2 or 7 of the valve V_6). The measured sensitivity should not be worse than 30 MV on all six fixed frequencies. The measurements are made with the supply voltage of the receiver equal to 27 volts.

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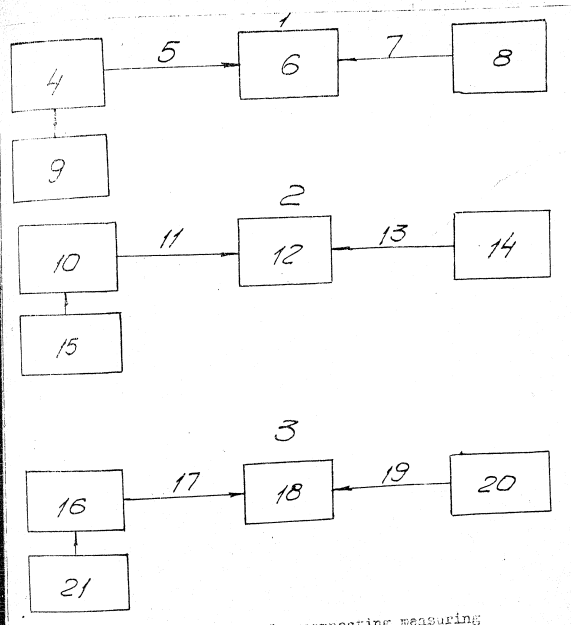

Fig. 70. Block diagram for connecting measuring equipment and measuring electrical parameters of receivers.

1. Block diagram for measuring sensitivity and A.G.C. 2. Block diagram for measuring bandwidth of intermediate frequency amplifier. 3. Block diagram for measuring discriminator characteristics 4. Signal generator СГ-1 5. To receiver input 6. КРП-Ф receiver 7. To pin 3 or 7 of valve V_{10} 8. Output meter, ИВ-4 9. Audio generator ЗГ-2А 10. Standard signal generator ГСС-6 11. To 1st pin of valve V_2 12. КРП-Ф receiver 13. To pin 3 or 7 of valve V_{10} 14. Output meter, ИВ-4 15. Audio generator ЗГ-2А 16. Standard signal generator ГСС-6 17. To 1st pin of valve V_9 18. КРП-Ф receiver 19. To 5th pin of valve V_7. 20. Valve voltmeter ВК-2 21. Audio generator ЗГ-2А

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Measuring the intermediate frequency bandwidth.

The intermediate frequency bandwidth is measured in the following way: the grid of the mixer valve (V_2, pin 1) is supplied via a capacitor of 100-200 pF with an intermediate frequency signal from the ГСС-6 standard signal generator, modulated by a voltage having a frequency of [illegible] C/s to a depth of [illegible]. Set the output voltage of the standard signal generator such as to have a voltage of 1 volt at the grid of the phase detector ($V_{[illegible]}$, pin 3 or 7), as measured with an ИВ-4 instrument. Increase the signal of the standard signal generator two-fold and then vary its frequency in both directions until a voltage of 1 volt is again obtained at the detector grid. The value of the detuning of the standard signal generator in kilocycles/second in both directions will determine the bandwidth at the 0.5 level. The value of the bandwidth at the 0.1 and 0.05 levels is determined by a similar method, with the generator output voltage increased 10 and 100 times, respectively.

When measuring, the constant-phase channel is shorted to earth (V_6, pin 2 or 7).

Checking the operation of the A.G.C.

The operation of the A.G.C. of the receiver is checked in the following way: the receiver input is supplied with an r.f. voltage from the СГ-1 generator. The modulating voltage has a frequency of 60 c/s, the modulation factor is 30%. With the output voltage of the СГ-1 set to 40 MV and 20,000 MV and the grid of the valve V_6 (pin 2 or 7) shorted to earth, the voltage at the grid of the phase-detector valve is measured with the aid of an ИВ-4 instrument.

The quotient obtained by dividing the output voltages, measured at the grid of the phase detector, at input signals of 40 and 20,000 MV should not exceed 2.

Checking the characteristic of the discriminator

The discriminator characteristic is checked by applying the intermediate frequency from a standard signal generator to grid

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of the first intermediate frequency valve (V_3, pin 1). The i.f. [illegible] modulated by a frequency of 10 Kc/s from an audio frequency generator to a depth of 10%. The output voltage of the [illegible] signal generator is set at 0.1 volts.

[illegible] voltage across the discriminator load (V_7, pin 5) [illegible] by means of a type [illegible]-2 voltmeter. The frequency is [illegible] which the voltage across the load of the discriminator [illegible] to zero. This frequency should be 10 Kc/s ± 150 c/s. [illegible] frequency of the standard signal generator is varied by [illegible] and the voltage across the load at the extreme frequency [illegible] determined.

[illegible] voltage across the discriminator load for a detuning [illegible] Kc/s should not differ by more than 20% from the medium [illegible]

Checking the main parameters of the amplitude attachment without the КРП-Ф and ГРП-2 receivers.

1. Connect the amplitude attachment according to the diagram in Fig.71

2. Supply the input of the amplitude attachment, via a voltage divider, with voltages of 90 c/s and 150 c/s, each having an amplitude of 2.5 volts, from audio frequency generators No.1 and No.2. The output voltages of the audio frequency generators are set in the following way:

a) Set the switch "ВНУТР.НАГРУЗКА "("INTERNAL LOAD") of the audio frequency generators, type ЗГ-10, No.1 and No.2 in the position "ВКЛ ("ON"), the knob "ВЫХ. ("OUTPUT RESISTANCE") in the position "5000";

b) set the knobs "ЗАТУХАНИЕ ДВ" "("ATTENUATION DB") "100" and "10" of ЗГ-10 No.1 in the positions "100" and "10", and those of ЗГ-10 No.2 - in the positions "0" and "5";

c) set the knob "РЕГ -ВЫХ. НАПР" ("OUT.VOLT.CONTROL") of ЗГ-10 No.2 to an output voltage of 2.5 v, according to a [illegible]-7 valve voltmeter;

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Fig. 11

1'. Input of signal 2' + 27 volts 3'. From ГРП-2
4'. To the same shunt 4КРП-Ф 5'. To ПСП-48, КРП-Ф 6'. To ПСП-48, КРП-Ф
7'. Earth 8'. Signaling current, КРП-Ф 9'. + 200 V. 10'. From ГРП-2
11'. Signaling current, КРП-Ф 12'. Course 13'. To ПСП-48, КРП-Ф
14'. To ПСП-48, ГРП-2 15'. Localizer
16'. Glide-slope 17'. Glide-slope 18'. Microammeter

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d) set the knobs "ЗАТУХАНИЕ дБ" "10dB" and "1dB" of ЗГ-10 No.1 in the positions "0" and "5", and those of ЗГ-10 No.2 in the positions "10" and "10";

e) set the knob "УРОВЕНЬ ВЫХ." of ЗГ-10 No.1 to an output voltage of 2.5 volts, according to the ЛВ-2 valve voltmeter;

f) set the knob "ЗАТУХАНИЕ дБ" "10dB" and "1dB" of ЗГ-10 No.1 and No.2 to the positions "0" and "5", respectively.

3. Set the potentiometer "ЧУВСТВ." ("SENSITIVITY") of the amplitude attachment in the middle position. Set the potentiometer "БАЛАНС" ("BALANCE") to obtain zero reading on a microammeter connected in circuit with the two series-connected windings of the ПОИ-48 indicators.

4. Increase the output voltage of ЗГ-10 No.1 by 5 dB and decrease the output voltage of ЗГ-10 No.2 by 5 dB. By means of the potentiometer "SENSITIVITY" set a current of 180 MA through the microammeter.

Note: The microammeter used for measuring current should have a low internal resistance (not more than 250 ohms).

5. Decrease the output voltage of ЗГ-10 No.1 by 5 dB, and increase the output voltage of ЗГ-10 No.2 by 5 dB. Note the reading of the microammeter.

6. If the current differs from 180 MA by more than ± 10%, then it is necessary to check the setting of the balance unit, with the aid of the potentiometer "SENSITIVITY" to set a microammeter current equal to the half-sum of the currents obtained as a result of measurements made according to par.3 and 4 and to measure currents again.

7. Switch on the battery and by turning the knob of the potentiometer R_4 (see Fig.8) obtain a deflection to the fourth dot- the scale stop- of the pointer of the glide-slope indicator. In this case, when the ± 27 volts are switched on and off the

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[illegible] of the glide-slope indicator should pass from the [illegible] position to the lower and vice versa.

CHOICE OF THE RATINGS OF CAPACITORS AND RESISTORS SELECTED DURING ALIGNMENT

[illegible] circuits of the РСП-2 and КРП-Ф, 41 receivers and the [illegible] attachment include a number of capacitors and resistors [illegible] of which are selected during alignment. Usually, the [illegible] these resistors correspond to the ratings indicated in [illegible] and wiring diagrams, however there are cases when [illegible] need to be selected in order to ensure the given [illegible] of the receivers.

[illegible] limits within which the ratings may be varied are indi- [illegible] the list of parts.

In the КРП-Ф receiver the following resistors are selected during alignment:

1. Resistor R_{24} which may vary from 1 to 3.3. K-ohms. [illegible] resistor is included in the cathode circuit of the second [illegible] of the constant-phase amplifier (which is simultaneously a [illegible]). This resistor is selected to obtain the necessary stage [illegible] which the required amplitude limiting of the signal occurs.

2. The resistor R_{28}, which shunts the tuned circuit L_{11}, [illegible] of the discriminator is included during alignment in those [illegible] when the gain of the discriminator legs differs by more than 20%. By selecting the value of R_{28} within 0 to 47 K-ohms identical voltage gain of the legs of the discriminator circuit is obtained.

3. Resistor R_{29} which may vary from 27 to 36 ohms. The resistor is included in the anode circuit of the radio frequency amplifier valve and serves as an antiparasitic resistor.

4. The rating of the resistor R_{39} is selected during alignment of the receiver within 100 to 680 ohms in such a way that the stage would provide again ensuring a constant-phase voltage of 8-12 volts at the grids of the phase detector V_{10}.

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4. The rating of the resistor R_{48}, which can vary from 5.2 to 33 K-ohms, is selected during alignment of the receiver in such a way that when the sensitivity potentiometer (R_{42}) is turned fully counter-clockwise the pointer of the MCU-4C course indicator would deflect on reception of a signal from 0 to the last dot of the scale and when the potentiometer is turned fully clockwise the pointer would deflect beyond the first dot of the scale.

5. The resistor R_{46} which may vary from 6.8 to 10 K-ohms. The resistor is included in the cathode circuit of the valve V_{10} and provides the necessary bias voltage at the valve grids.

6. In order to obtain the required operating sensitivity of the emergency signalizer, the rating of the resistor R_{47}, shunting the signalizer coil winding, is selected within 270 to 300 ohms (when operating with an MCU-4C indicator) and within 1 to 1.5 K-ohms (when operating with two MCU-4C indicators).

Should the emergency signalizer fail to operate with reduced voltage (24.5 volts), it is necessary to replace the resistor R_{47} by one of a higher rating. If the signalizer operates without a signal at an increased supply voltage (29.7 v) R_{47} should be replaced by a resistor of a lower rating.

8. The rating of the resistor R_{49}, which may vary within 3.3. to 5.1 K-ohms, is selected in such a way that there is no spurious operation of the signalizer after the receiver has been kept in a cold chamber. If the signalizer tends to operate spuriously, the resistor R_{49} should be increased.

9. In case, when the variable phase is changed by means of the current flowing through the indicator winding pointer of the course indicator deflects by more than 2° from the zero position, the resistor R_{42} or R_{43}, which may vary from 2.5 to 5 K-ohms is included in the circuit of one of the grids of the valve V_{10}. In those cases when the current deflecting the pointer to the left exceeds the current deflecting the pointer to the right the resistor R_{42} is installed and, conversely the resistor R_{43} is installed when the effect is the opposite.

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In the ТРП-2 receiver the following capacitors and resistors are selected during alignment:

1. The resistor R_{22} which may vary from 51 to 82 K-ohms. The resistor is included in the anode circuit of the left half of the valve V_6 of the 1st audio frequency stage. This resistor is selected to obtain the optimum A.G.C. characteristic, having a steep initial section and not allowing cut-off of the receiver by strong signals.

2. The resistor R_{24} which can be varied within [illegible] K-ohms. The resistor is included in the anode circuit of the left half of the valve V_8 and serves as an antiparasitic resistor.

3. The resistor R_{50} which can be varied from 220 to 330 K-ohms. This resistor is included at the receiver output and serves for branching off part of the output current.

4. The capacitor C_{10} which may be varied from [illegible] to [illegible] pF. This capacitor which is connected from the outlet of the coaxial tuned circuit to earth serves for shortening the electrical length of the coaxial circuit, and, consequently for decreasing the value of the trimming capacitor and increasing the frequency stability of the circuit.

5. The capacitor C_{28} which can be varied from [illegible] to 30 pF. This capacitor is included for the same purpose as resistor R_{22}.

6. The capacitor C_{39} which can be varied from [illegible] to [illegible] pF. This capacitor, connected from the outlet of the coaxial tuned circuit to earth, is included for the same purpose as the capacitor C_{10}.

In the amplitude attachment, type АЛ-3 the following resistors are selected:

The resistor R_1 which can be varied from 80 to 360 K-ohms and the resistor R_{12} which can be varied from 12 to 20 K-ohms. The resistors are included in the voltage divider [illegible] and determine the magnitude of the signal [illegible] the amplitude attachment valve V_1.

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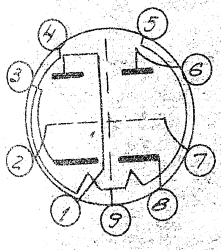
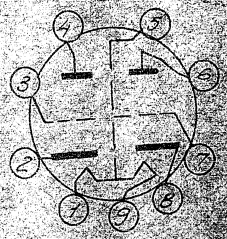
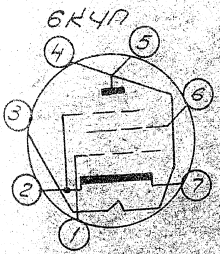
6Н2П



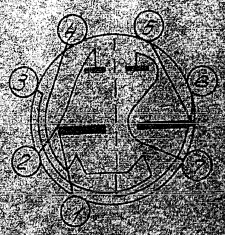
6Н3П



6Ж1П
6К4П



6Х2П



Фиг. 22

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the voltage is applied to terminals 1 and 3 of the capacitors unit connector and the "-" to terminals 2 and 7. After training it is necessary to measure the leakage resistance of the capacitors between terminals 1 and 2; 3 and 7, the value of which after charging of the capacitors should not be less than 20 K-ohms.

Warning: 1. After one hundred hours of operation of the amplitude attachment, check the heater voltage of the 6Ш3 valve. The heater voltage is adjusted by means of the potentiometer R_c at a network voltage of 27 volts. In this case the heater voltage should be 6.3 v ± 3%.

2. In case of failure of the amplitude attachment, possible violation in the operation of the ГрП-2 and КРП-Ф receivers in the "СП-50" system should be averted by disconnecting the supply cable from the amplitude attachment and connecting it to the receptacle "ЗАГЛУШКА" ("PLUG-CAP") and setting the switch "СП-50 - ИМС" in the position "СП-50".

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Pin numbers of the electrodes of the EVL-1 valves

Electrodes	Valve numbers								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
Heater	3	3	3	3	3	4	3	1	4
Heater	4	4	4	4	4	5	4	9	5
Cathode	2/7	2/7	2/7	2/7	1/9	3/8	2/7	2/8	3/8
Control grid	1	1	1	1	–	2/7	1	3/1	2/7
Screen grid	6	6	6	6	–	–	6	–	–
Anode	5	5	5	5	2/7	1/6	5	4/6	1/6
Screen	–	–	–	–	11	9	–	5	9

Table of valve electrode voltages with respect to earth

Electrode number	Valve number									Note
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	
1	-1.05	0	0	0	6.6	60	-2.8	6.3	60	
2	0	2.4	2.4	1.05	0	6	0	0	2.6	
3						6.3		2.7	0	
4	6.3	6.3	6.3	6.3	6.3		6.3	50		
5	250	115	115	70	6.6	6.3	110	0	6.3	
6	40	115	115	60	0	200	50	75	60	
7	0	2.4	2.4	1.05	6	0	0	1.4	2.5	
8						4		0	6	
9						0		6.3	0	

Arrangement of the electrodes of the EVL-1 valves

(see the following page)

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Valve number													
Manufacture	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}
Base	3	3	3	3	3	3	3	3	4	4	4	3	4
Heater	A	4	4	4	4	4	4	4	9	9	9	8	9
Cathode	2/7	2/7	2/7	2/7	4/8	3/8	1/8	3/8	2/8	2/8	2/8	2/7	2/8
Control grid	1	1	1	1	-	2/7	-	2/7	3/9	3/7	3/7	1	3/7
Screen grid	6	6	6	6	-	-	-	-	-	-	-	6	-
Anode	5	5	5	5	2/9	1/6	2/9	1/6	4/8	4/6	4/6	5	4/6
Screen	-	-	-	-	8	9	8	9	5	5	3	-	5

Table of valve electrode voltages with respect to earth

Valve-node number	Valve number												
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}
1	-1.5	0	-1.5	-4.5	42	205	0	160	6.3(1-9)	6.3(1-9)	6.3 (1-9)	-4.5 (1-9)	6.3 (1-9)
2	0	0.7	0	0	-	-1.5	-0.9	0	4	3.5	0	0	0
3						0		1.5	0	0	-7	6.3	-120
4	6.3	6.3	6.3	6.3	6.3		6.3		175	100	135		-120
5	135	65	155	155	42	6.3	0.2	6.3	0	0	0	120	-
6	105	55	100	105	-	135	-	140	140	100	72	120	200
7	0	0.7	0	0	1.5	6	-0.9	13	8	0	-17	0	-1.5
8	-	-	-	-	-	1.05	-	40	2.3	3.5	0	-	0
	-	-	-	-	-	-	-	0	6.3(9-1)	6.3 (9-1)	6.3 (9-1)	-	6.3 (9-1)

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Table of electrode voltages of the AN valve

Valve type	Ua volts	Uh volts	Uc volts	Uk volts	Uh volts
	Valve pins				
	5	9	7	8	1
[illegible]	160-190	6.3±10%	0	3.6-5	0

Note: 1. All voltages are measured with the aircraft network at 27 v and the anode voltage at 200 v.

2. Voltages at valve electrodes are measured with respect to the chassis with a voltmeter, type TS-1 or [illegible].

3. Valve heater voltage is measured between the two heater pins of the valve. The voltage tolerance is ± 10%.

4. Voltages marked by an asterisk are measured with a valve voltmeter. The voltage tolerance is ± 30%.

GUARANTEE OF THE SUPPLIER

The manufacturing Works guarantee practically 100% trouble-free operation of the ГРН-2, КРН-5 and АН equipments during 1000 flying hours throughout 3 years, which include not more than 2 years of operation directly in aircraft, the rest of the time being spent in transportation and storage at warehouses of the Purchaser and User.

During storage, failure of the amplitude attachments is possible due to failure of articles making up the set, the failure of which is permissible according to the specifications of the articles. The manufacturing Works guarantee to repair free of charge those equipments which have failed for any reason except violation of storage rules, careless handling in operation and failure of articles making up the set, the failure of which during operation and storage is permissible according to their specifications.

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POSSIBLE FAULTS AND METHOD OF ELIMINATING THEM

When seeking the causes of faults in any of the equipments described above, the main rules should be observed not to check first for the simplest cause, for example open circuits in cables, open contacts and connectors, low network voltage, faulty valves, only after there is complete certainty that the above components are in order should the cause of poor operation be sought in the receiver circuit. It should be borne in mind that an overload on or a faulty receiver can often cause failure of good assemblies and parts. In order to avoid such cases, it is necessary before checking voltages at the assemblies and parts of a faulty receiver to check the resistances, according to the resistance chart (see Appendix No. 23 for the PPM-2 receiver and Appendix No. 24 for the KPM-6 receiver).

The resistance chart makes it possible to check with the aid of an ohmmeter all of the receiver circuits with the exception of the heater circuits. Checking is carried out from both the valve side or the circuitry side, with the valves either removed and the receiver switches off. Resistances are measured with respect either to the high voltage lead, the a.f.c. circuit or the receiver chassis.

Typical finding faults of the PPM-2, KPM-6 and AM, are given in Tables 6, 7 and 8 respectively.

Table No. 6

Possible single faults of the PPM-2 and methods of eliminating them

No.	Symptom	Cause	Remedy
1.	When power is switched on dynamotor does not operate.	Burnt-out fuse of PPM-2 receiver in distribution box. Bad contact in supply connector or receiver or control box. Bad contact in dynamotor connector. Faulty dynamotor.	Replace burnt-out fuse. Check contacts. Replace dynamotor.)

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POSSIBLE FAULTS AND METHODS OF ELIMINATING THEM

When seeking the causes of faults in any of the equipments described above, the main rules should be adhered to: to check first for the simplest cause, for example open circuits in cables, open contacts and connectors, low network voltage, faulty valves.

Only after there is complete certainty that the above components are in order should the cause of poor operation be sought in the receiver circuit. It should be borne in mind that switching on of a faulty receiver can often cause failure of good assemblies and parts. In order to avoid such cases, it is necessary before checking voltages at the assemblies and parts of a faulty receiver to check the resistances, according to the resistance chart (see appendix No. 23 for the TPH-2 receiver and appendix No. 24 for the KPH-6 receiver).

The resistance chart makes it possible to check with the aid of an ohmmeter all of the receiver circuits with the exception of the heater circuits. Checking is carried out from either the valve side or the circuitry side, with the valves removed and the receiver switches off. Resistances are measured with respect either to the high voltage line, the A.G.C. circuit or the receiver chassis.

When finding faults of the TPH-2, KPH-6 and AH, consult Tables 6, 7 and 8 respectively.

Table No. 6

Possible simple faults of the TPH-2 and methods of eliminating them

No.	Symptom	Cause	Remedy
1.	When power is switched on dynamotor does not operate	Burnt-out fuse of TPH-2 receiver in distribution box. Bad contact in supply connector on receiver or control panel. Bad contact in dynamotor connector. Faulty dynamotor.	Replace burnt-out fuse. Check contacts. Replace dynamotor.x)

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No.	Symptom	Cause	Remedy
2.	[illegible] on any [illegible] then operating [illegible] imitator.	Faulty valve, [illegible] not supplied, no contact in dynamotor connector, faulty dynamotor or o/c in wiring. Failure of resistor or decoupling capacitor in supply circuit of one of the stages.	Find faulty valve according to voltage table and replace. Find faulty component according to voltage table and replace.
3.	[illegible] reception on [illegible]	Poor contact in switch on control panel, relay or crystal-holder. O/c of relay coil. Faulty crystal.	Adjust contact or replace panel. Replace relay. Replace crystal.
4.	Indicator pointer does not deflect on one modulation frequency (90 or 150 c/s)	O/c in wiring. Failure of 90 or 150 c/s filter. Faulty copper-oxide rectifier. Damaged indicator.	Find o/c. Replace filter. Replace copper-oxide rectifier. Replace indicator.
5.	When operating, indicator pointer deflects but emergency signalizer does not operate.	Poor contact in indicator connector. Faulty resistor (R_{29} or R_{30})	Check contacts. Check circuit and replace faulty circuit components.
6.	During operation of receiver, indicator pointer does not deflect, emergency signalizer operates.	Poor contact in indicator connector. Faulty indicator.	Check circuit. Replace indicator.

x) Repair dynamotor according to instructions of Manufacturing Works.

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No.	Symptom	Cause	Remedy
7.	Low sensitivity of receiver	Low network voltage. Valves have lost emission or one of receiver circuits has become detuned.	Check network voltage. Receiver should be checked stage-by-stage with aid of measuring equipment in laboratory. Check up should be made by highly skilled personnel.
8.	Not operating in connection with a PPM-2 set, the dynamotor does not operate on one band.	Winding of one of relays short-circuits PPM-2 relay.	Check circuit and replace faulty relay.

Table No. 7

Possible simple faults of the PPM-2 and methods of eliminating them

No.	Symptom	Cause	Remedy
1.	When toggle switch "PPM" on control panel is switched on, the dynamotor does not turn.	Burnt-out fuse in supply circuit. No contact in toggle switch. 9-terminal connector of dynamotor poorly inserted. Dynamotor faulty. No contact in supply connectors.	Replace fuse. Replace toggle switch. Check and clean contacts in supply connector. Repair or replace dynamotor.
2.	Dynamotor turns but indicator pointer does not reflect when "Balance" potentiometer is turned.	Faulty GMTN valve V_{10}, faulty bridge of phase detector (V_{10}), faulty control panel.	Replace valve V_{10}. Check anode supply circuit and eliminate fault of control panel.

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No.	System	Cause	Remedy
3.	Indicator pointer has gone beyond the scale to left or to right.	"Balance" out of adjustment. One of the resistors in the anode circuit of the valve V_{10} has burnt out. Breakdown of capacitor C_{51} or C_{52}.	Check and set "Balance" potentiometer. Check resistors and replace faulty one. Replace capacitor C_{51}, C_{52}.
4.	When checking with imitator, no deflection of indicator pointer to left or right. Indicator pointer does not deflect when "Sensitivity" potentiometer is turned while the emergency signalizer operates normally.	Breakdown of capacitor C_{50}. Sensitivity control set to minimum. Shorted contact in "[illegible]" pushbutton or relay C_7.	Set control in required position. Replace capacitor C_{50}. Adjust contacts.
5.	No negative voltage at pins 1-3 of the valve V_{13}.	Faulty valve V_{13} 6Н3П.	Replace valve V_{13} 6Н3П.
6.	No local oscillator current in jacks between resistors R_{55}, R_{56}, R_{54}, R_{58}, R_{61}, R_{62} and all crystals.	Faulty valve V_{11} 6Н3П or V_{12} 6Н1П.	Replace valve V_{11} 6Н3П or V_{12} 6Н1П.
7.	No local oscillator current in jacks between resistors R_{55}, R_{56} and one crystal.	Faulty crystal. Faulty crystal relay. Poor contact in supply connector or control-panel switch.	Replace crystal. Check relay and clean contacts. Eliminate poor contact.

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No.	Symptom	Cause	Remedy
8.	One of the crystal relays does not operate.	Faulty relay circuit. O/c of relay winding. Winding shorted by broken-down winding of РРП-2 relay.	Check relay circuit and eliminate poor contact. Replace relay. Check РРП-2 relay.
9.	Emergency signalizer flap does not operate when receiver operates normally.	Faulty emergency signalizer circuit.	Check emergency signalizer circuit with ohmmeter.
10.	When checking with [illegible], course [illegible] pointer does not deflect or deflects very [illegible], receiver consumes a current of over 3 amp at normal supply voltage of 27 v.	Anode circuit shorted to chassis. S/c in wiring.	Check valve operating conditions and, having found site of s/c, eliminate fault.

Table No. 8

Possible simple faults of the АП and methods of eliminating them

No.	Symptom	Cause	Remedy
1.	When switch is set in the position "ИЛС" 27 volts are not applied to the attachment.	Poor switch contact. Poor contact in attachment connector.	Check switch contacts and connector contacts and clean if necessary.
2.	No signal applied to amplitude attachment input from КРП-Ф	Poor contact in relay P_1 or in connector.	Check contacts of relay P_1 and connector and clean if necessary.

Лит. изм. | к-во | № приказа | Подпись | Дата | Лит. изм. | к-во | № приказа | Подпись | Дата | Разработ. | Проверил

Копировал

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No.	Symptom	Cause	Remedy
3.	The course indicator pointer and the glide-slope indicator pointer do not deflect in either the "СП-50" or "МАС" systems.	Poor contact in amplitude attachment relays P_2, P_3.	Check the windings and contacts of the relays P_2, P_3 and replace relays if necessary.
4.	When operating in the "МАС" system, the polarity of the glide-slope indicator pointer does not change.	Poor contact in relay P_3.	Check relay contacts and if necessary replace relay.
5.	No deflection of course indicator pointer of ПСП-48 in "МАС" system.	Faulty valve 6Н3П	Replace valve.
6.	Cannot be balanced in КРП-3 receiver in "МАС" system.	Faulty rectifier "АВК-II".	Replace rectifier "АВК-II".
7.	No deflection of course indicator pointer of ПСП-48 on one of the modulation frequencies 90 or 150 c/s.	Corresponding filter faulty.	Check 90 and 150 c/s filters and if necessary replace.

Warning: When the supply voltage of the ГРП-2 and КРП-3 receivers is switched on, do not remove valves from their valveholders, as they are connected in series-parallel groups.

In order to facilitate checking of various units of the receiver, tables are given of the valve electrode pin number, the valve electrode voltages with respect to the chassis, and resistance charts.

When finding receiver faults, proceed in the following order:

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1. Check the radio frequency channel with the aid of the indicator.
2. Check the radio frequency panel with the aid of the multimeter.
3. Clear this remove the receiver lids and check the valve operating conditions.
4. If the valve operating conditions are normal, find the faulty circuit component.

Warning: Do not touch the alignment controls of the receiver until it has been established conclusively that one of the tuned circuits are exactly which has become detuned.

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Appendix No.1

LIST OF PARTS OF THE IPP-2 RECEIVER

Circuit symbol	U.S.S.R. standard Specif. drawing No.	Description and type	Main rating	Quantity	Note
1	2	3	4	5	6
R_1	MO.467.004 TU	Resistor BC-0.25 470 K-ohms-II	470 K-ohms	1	
R_2	OE.467.003 TU	" MJ-0.5 470 K-ohms-II	470 K-ohms	1	
R_3	OE0.467.004 TU	" BC-0.5 82 K-ohms-II	82 K-ohms	1	
R_4	OE0.467.004 TU	" BC-0.25 1 megohms-II	1 megohm	1	
R_5	OE0.467.004 TU	" BC-0.25 510 ohms-I	510 ohms	1	
R_6	OE0.467.004 TU	" BC-0.5 8.2 K-ohms-II	8.2 K-ohms	1	
R_7	OE0.467.004 TU	" BC-0.25 1 megohms-II	1 megohm	1	
R_8	OE0.467.004 TU	" BC-0.5 510 ohms-I	510 ohms	1	
R_9	OE0.467.004 TU	" BC-1 3.3 K-ohms-II	3.3 K-ohms	1	
R_{10}	OE0.467.004 TU	" BC-0.5 6.2 K-ohms-II	6.2 K-ohms	1	
R_{11}	OE0.467.004 TU	" BC-0.25 510 ohms-I	510 ohms	1	
R_{12}	OE0.467.004 TU	" BC-0.25 360 K-ohms-II	360 K-ohms	1	
R_{13}	OE0.467.004 TU	" BC-0.25 68 K-ohms-II	68 K-ohms	1	
R_{14}	OE0.467.004 TU	" BC-0.25 68 K-ohms-II	68 K-ohms	1	
R_{15}	OE0.467.004 TU	" BC-0.25 47 K-ohms-II	47 K-ohms	1	
R_{16}	OE0.467.004 TU	" BC-0.25 470 K-ohms-II	470 K-ohms	1	

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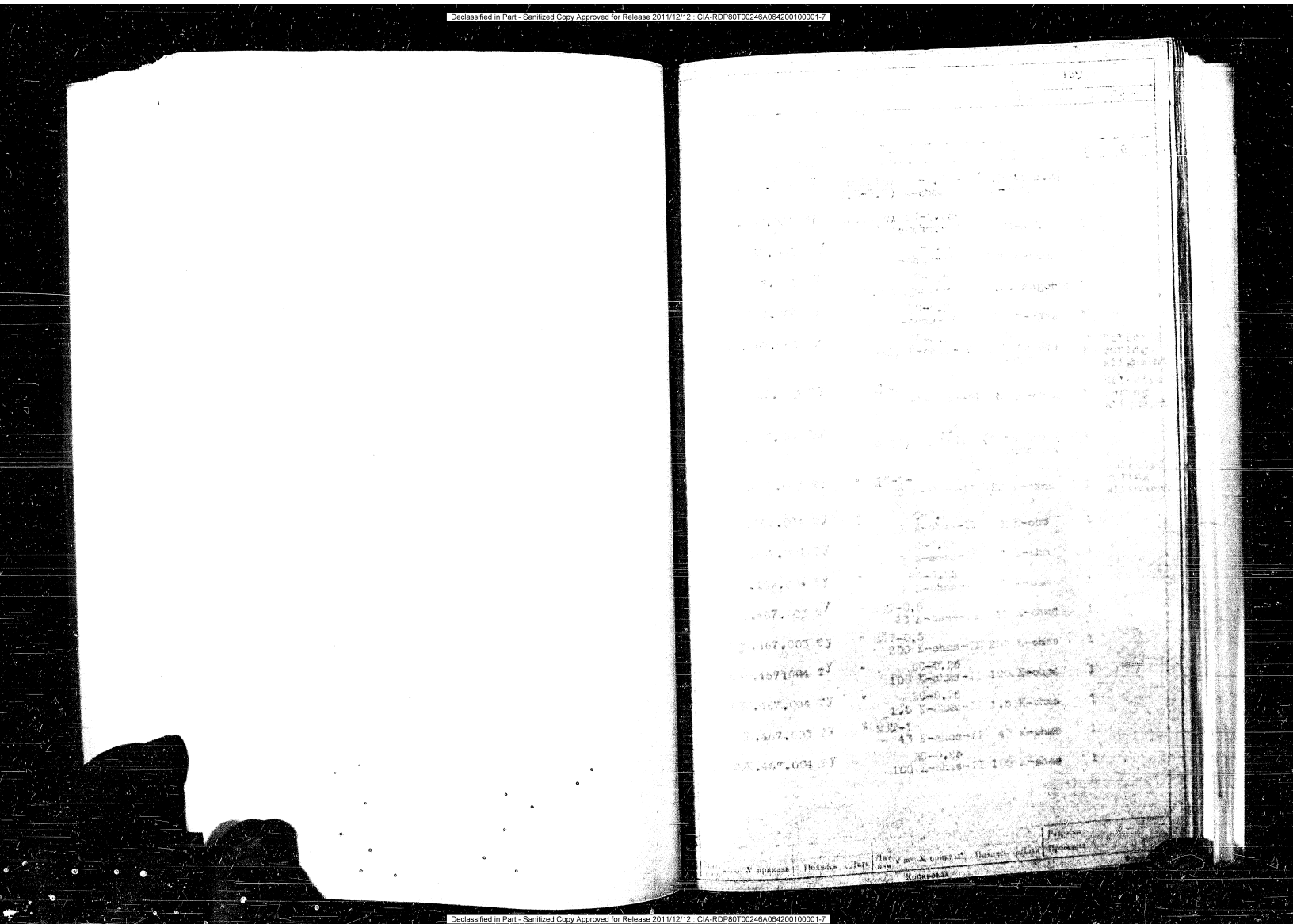

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[illegible].004 ТУ	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible] ТУ	"	[illegible]	[illegible]	[illegible]	
[illegible].004 ТУ	"	[illegible]	[illegible]	[illegible]	
[illegible] ТУ	"	[illegible]	[illegible]	[illegible]	
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[illegible].004 ТУ	"	[illegible]	[illegible]	[illegible]	
[illegible] ТУ	"	[illegible]	[illegible]	[illegible]	
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[illegible] ТУ	"	[illegible]	[illegible]	[illegible]	
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[illegible] ТУ	"	[illegible]	[illegible]	[illegible]	[illegible]
[illegible].004 ТУ	"	[illegible]	[illegible]	[illegible]	
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[illegible].004 ТУ	"	СП-II-2b-[illegible]	[illegible] K-ohms	1	
[illegible].034.007	"	2 ohms	2 ohms	1	
[illegible].634.018	"	14 ohms	14 ohms	1	
[illegible].634.006	"	75 ohms	75 ohms	1	
[illegible].467.004 ТУ	"	ВС-0.25 51 ohms-II	51 ohms	1	
[illegible].467.004 ТУ	"	ВС-0.25 51 ohms-II	51 ohms	1	

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1	2	3	4	5	6
R_{58}	[illegible].467.004 ТУ	Resistor [illegible]-0.25 51 ohms-II	51 ohms	1	
R_{59}	[illegible].467.003 ТУ	" МЛТ-0.5 510 ohms-II	510 ohms	1	Included for "ILS" operation
R_{60}	[illegible].467.003 ТУ	" МЛТ-0.5 510 ohms-II	510 ohms	1	
C_1	[illegible].460.014 ТУ	Capacitor КТК-1-М-2-11	2 pF	1	
C_2	[illegible].460.014 ТУ	" КТК-1-Д-3-11	3 pF	1	
C_3	[illegible].460.013 ТУ	" КТК-[illegible]-51-1	51 pF	1	
C_4	[illegible].460.013 ТУ	" КГК-2-М-51-1	51 pF	1	
C_5	[illegible].460.014 ТУ	" КДК-1-М±0.4	1 pF	1	
C_6	ГОСТ 6119-54	" КСО-2-500-А-680-III	680 pF	1	
C_7	ГОСТ 6119-54	" КСО-2-500-А-680-III	680 pF	1	
C_8	[illegible].460.014 ТУ	" КТК-1-Д-150-II	150 pF	1	
C_9	ГОСТ 6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{10}	ОЖ0.460.014 ТУ	" КТК-1-С-(0-3)-II	(0 to 3) pF	1	Selected during alignment
C_{11}	ОЖ0.460.013 ТУ	" КГК-2-М-51-I	51 pF		
C_{12}	ОЖ0.460.013 ТУ	" КГК-2-М-51-I	51 pF	1	
C_{13}	ОЖ0.460.014 ТУ	" КДК-1-М-1±0.4	1 pF	1	
C_{14}	ГОСТ 6119-54	" КСО-2-500-А-680-III	680 pF	1	
C_{15}	ГОСТ 6119-54	" КСО-2-500-А-680-III	680 pF	1	
C_{16}	ГОСТ 6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{17}	ГОСТ 6119-54	" КСО-2-500-А-680-III	680 pF	1	

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3	2	4	5	6
[illegible].013 ТУ	Capacitor [illegible]	51 pF	1	
[illegible].013 ТУ	" [illegible]	51 pF	1	
[illegible].014 ТУ	" [illegible]	1 pF	1	
[illegible]-54	[illegible]	[illegible]	1	
[illegible]-54	[illegible]	[illegible]	1	
6119-54	" [illegible]-680-[illegible]	680 pF	1	
[illegible].014 ТУ	" [illegible]	1 pF	1	
.460.013 ТУ	[illegible]	[illegible] pF	1	
.460.013 [illegible]	[illegible]	[illegible]	1	[illegible]
[illegible]-54	[illegible]	[illegible]	1	[illegible]
.460.014 ТУ	[illegible]-(15-30)-[illegible]	([illegible]) pF	1	
.460.014 ТУ	[illegible]-1-Д-150-[illegible]	150 pF	1	
.460.014 ТУ	[illegible]-1-Д-150-[illegible]	150 pF	1	
.462.[illegible] ТУ	" МБПП-1-[illegible]-0.5-[illegible]-5	0.5 pF	1	
.462.[illegible] ТУ	" МБПП-1-[illegible]-0.5-[illegible]-5	0.5 pF	1	
[illegible] 6119-54	[illegible]-2-500-[illegible]-1000-III	1000 pF	1	
6119-54	" [illegible]-5-250-[illegible]-10000-II	1000 pF	1	
ГОСТ 6119-54	[illegible]-2-500-[illegible]-680-III	680 pF	1	
[illegible].464.00[illegible] ТУ	" [illegible]-1-[illegible]-20-50 ohms	50 [illegible]	1	
ГОСТ 6118-52	[illegible]-200-[illegible]-II	0.[illegible] [illegible]	1	
ГОСТ 6119-54	[illegible]-5-250-[illegible]-10000-II	10000pF	1	

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1	2	3	4	5	6	7
C_{40}	ГОСТ 6119-54	Capacitor	КСО-5-250-В-10000-II	10000 pF	1	
$C_{40}a$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{40}b$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{40}c$	ГОСТ 6119-54	"	КСО-5-500-В-6200-II	6900 pF	1	
C_{41}	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{41}a$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{41}b$	ГОСТ 6119-54	"	КСО-5-500-В-3900-II	3900 pF	1	
C_{42}	ГОСТ 6119-54	"	КСО-5-500-В-5600-II	5600 pF	1	
$C_{42}a$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
C_{42}	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{42}a$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{43}b$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{43}c$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{43}d$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{43}e$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
C_{44}	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{44}a$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{44}b$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
$C_{44}c$	ГОСТ 6119-54	"	КСО-5-250-В-10000-II	10000 pF	1	
C_{45}	ОКС.160.014 Ту	"	КДК-1-М-1,5-ТП	1,5 pF	1	

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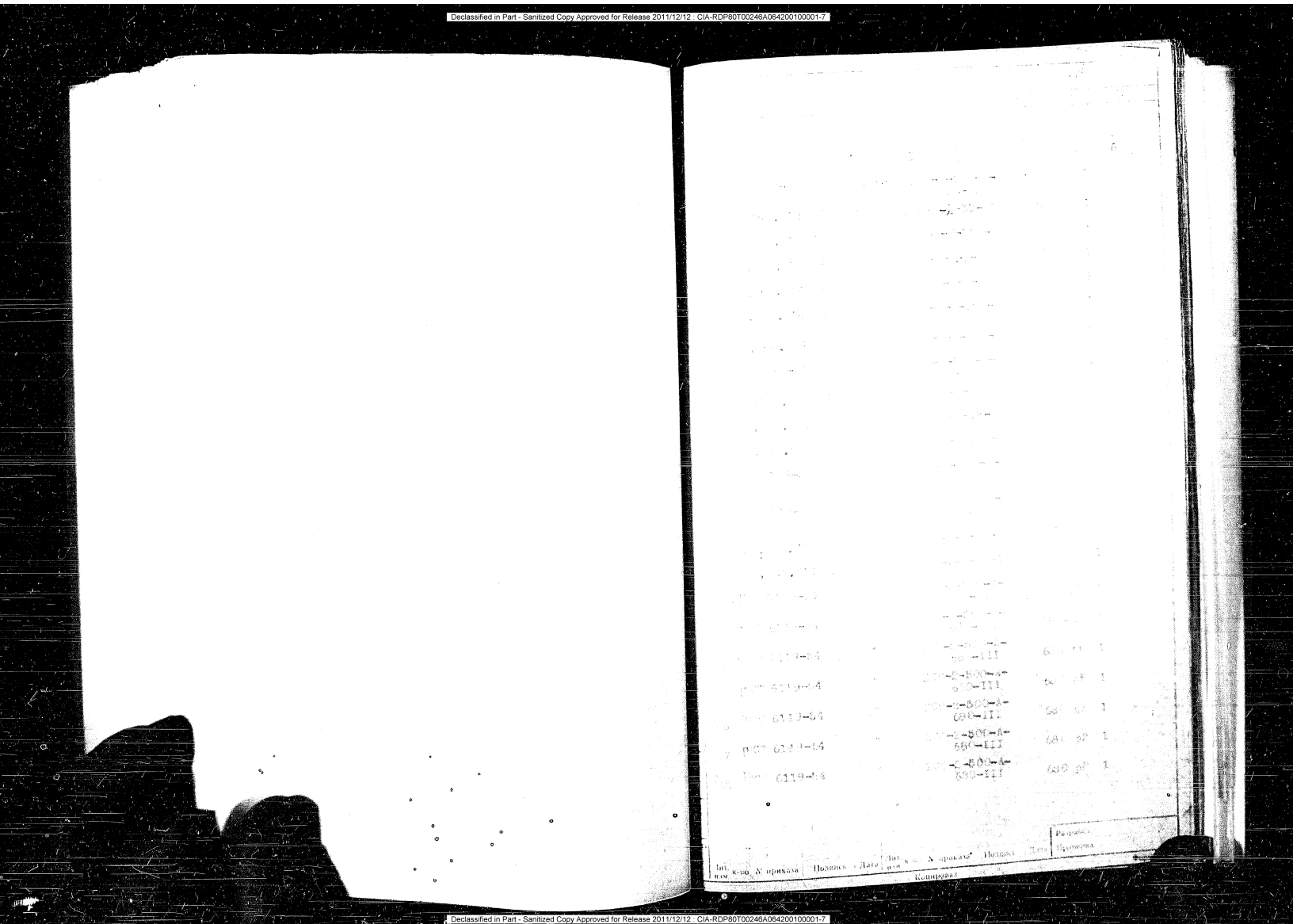

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				4	5	3
			КСО-5-500-А-2200-III	2000 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КЛС-1-Б-30-А-15-III	15 pF	1	
			КЛС-1-Б-30-А-15-III	15 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КСО-5-500-А-680-III	680 pF	1	
			КСО-5-500-А-5600-III	5600 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КДК-1-Д-150-II	150 pF	1	
			КСО-5-500-А-680-III	680 pF	1	
			ПЗМ-1-С-(2-8)-II	(2-to 8)pF	1	Selected during alignment
			КТИ-1-Д-150-II	150 pF	1	
			КСО-5-500-А-2200-III	2000 pF	1	

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Пров.
Н. контр.
Утв.

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1	2	3	4	5
[illegible]	[illegible].460.014 ТУ	Capacitor [illegible]	[illegible]	
L_1	ЕИ2.062.004 СП	Antenna coaxial tuned circuit		1
L_2	[illegible].062.005 СП	Grid coaxial tuned circuit		
L_3	[illegible].062.007 СП	48th harmonic coaxial tuned circuit		1
L_4	[illegible].062.025	24th harmonic tuned circuit		
L_5	[illegible].062.017	12th harmonic tuned circuit		
L_6	[illegible].062.027	6th harmonic tuned circuit		1
L_7	ЕИ5.062.023	2nd harmonic tuned circuit		1
L_8	[illegible].062.002	1st harmonic tuned circuit		1
L_9	[illegible].067.007 СП	1st IF filter coil (anode)		1
L_{10}	[illegible].067.007 СП	1st IF filter coil (grid)		1
L_{11}	[illegible].067.008 СП	IInd IF filter coil (anode)		1
L_{12}	[illegible].067.008 СП	IInd IF filter coil (grid)		1
L_{13}	[illegible].067.003 СП	IIIrd IF filter coil (anode)		1
L_{14}	[illegible].067.003 СП	IIIrd IF filter coil (grid)		1
L_{15}	[illegible].067.004 СП	IVth IF filter coil (anode)		1
L_{16}	ЕИ2.067.004 СП	IVth IF filter coil (Grid)		1
V_1	ТС.3.300.004 $ТУ_1$	Type 6Ж1П valve		1
V_2	ТС.3.300.004 $ТУ_1$	Type 6Ж1П valve		1
V_3	ТС.3.300.004 $ТУ_1$	Type 6Ж1П valve		1
V_4	ТС.3.300.004 $ТУ_1$	Type 6Ж1П valve		1
V_5	ТС.3.303.001 $ТУ_1$	Type 6Ж2П valve		1
V_6	ТС.3.301.005 $ТУ_1$	Type 6Н1П valve		1
V_7	ТС.3.300.004 $ТУ_1$	Type 6Ж1П valve		1
V_8	ТС.3.301.000 $ТУ_1$	Type 6Н3П valve		1
V_9	ТС.3.301.005 $ТУ_1$	Type 6Н1П valve		1
Tr_1	ЕИ2.067.006 СП	Filter transformer, 150 c/s		1
Tr_2	ЕИ2.067.006 СП	Filter transformer, 90 c/s		1
Ch_1	ЕИ2.067.006 СП	Filter choke, 150 c/s	33 H	1
Ch_2	ЕИ2.067.006 СП	Filter choke, 150 c/s	1[illegible] H	1
Ch_3	ЕИ2.067.005 СП	Filter choke 90 c/s	58 H	1
Ch_4	ЕИ2.067.005 СП	Filter choke, 90 c/s	190 H	1

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1	2	3	4	5	6
Ch_4	[illegible]4.750.002 СП	Anode choke		1	
Ch_5	[illegible]4.750.001 СП	Supply choke		1	
Ch_7	[illegible].754.008	RF choke		1	
Cr_1		Crystal I		1	
Cr_2		Crystal II		1	
Cr_3		Crystal III		1	
[illegible]	[illegible].214.133 ТУ	Copper-oxide rectifier АВК-1		1	
Y_1	[illegible]4.562.002 СП	Relay of crystal I		1	
Y_2	[illegible]4.562.002 СП	Relay of crystal II		1	
Y_3	[illegible]4.562.002 СП	Relay of crystal III		1	
[illegible]		Dynamotor -18-1		1	
[illegible]		Jack		1	
J_1	[illegible] 6.604.014	Two-pole connector socket		1	
Ch_1	[illegible] 6.604.009	Eight-pin connector plug		1	
Ch_2	[illegible] 6.672.032	Eight-pin connector socket		1	
Ch_3	[illegible] 6.672.032				
Ch_4	[illegible]0.364.002 ЧТУ	Connector ШР32УI4НШ5			

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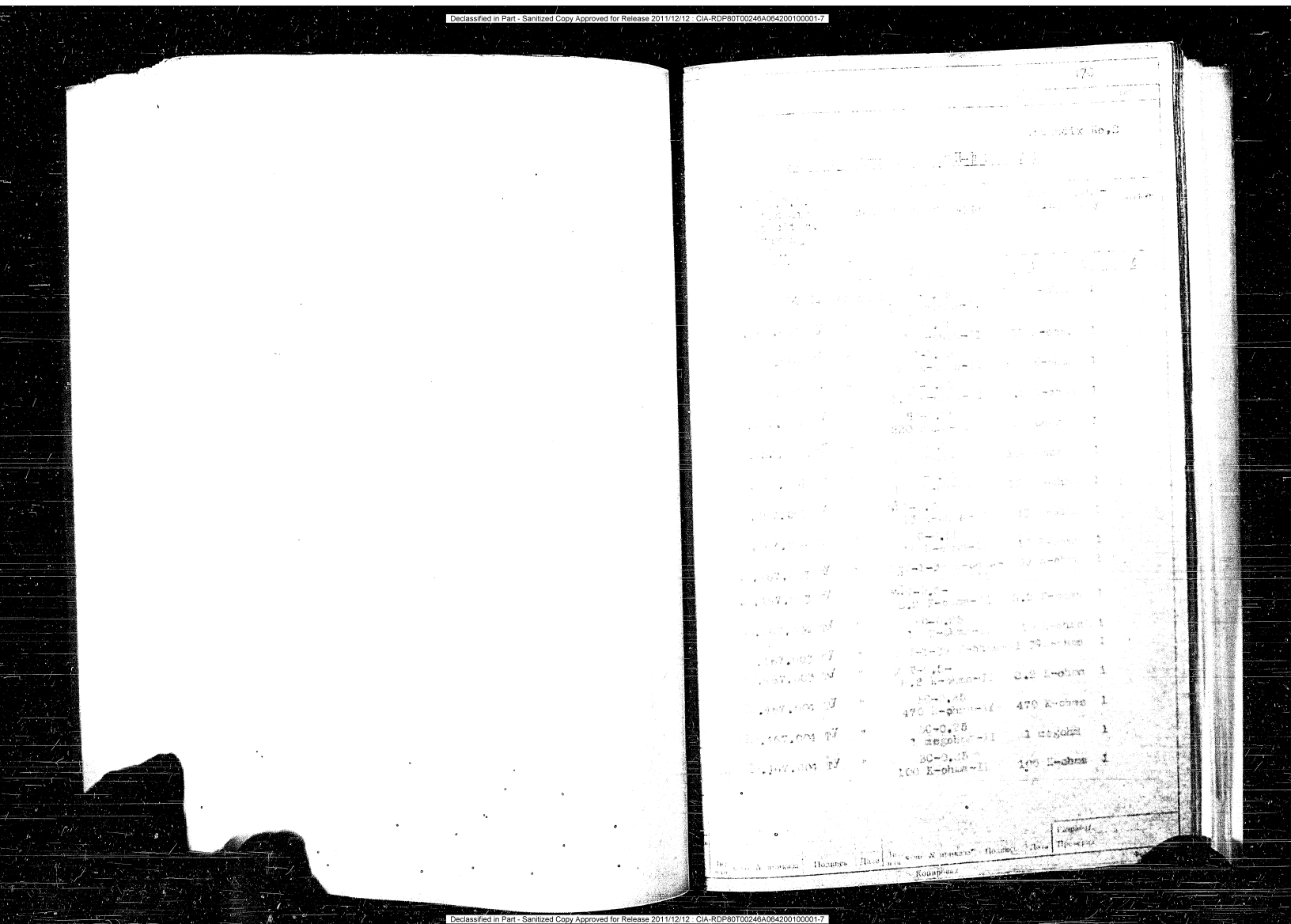

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1	2	3	4	5	6
R18	ОЖ0.467.004 ТУ Resistor	[illegible] 58 K-ohms-II	[illegible] K-ohms	1	
R19	ОЖ0.467.004 ТУ "	[illegible] 560 K-ohms-II	[illegible] K-ohms	1	
R20	ОЖ0.467.004 ТУ "	[illegible]	[illegible]		
R21	ОЖ0.467.004 ТУ "	[illegible] 560 K-ohms-II	[illegible]		
R22	ОЖ0.467.004 ТУ "	[illegible] 100 K-ohms-II	[illegible]		
R23	ОЖ0.467.004 ТУ "	[illegible] 470 K-ohms-II	[illegible]		[illegible]
R24	ОЖ0.467.004 ТУ "	[illegible] (1-[illegible]) K-ohms-II	[illegible]		
R25	ОЖ0.467.004 ТУ "	[illegible] 56 K-ohms-II	[illegible] K-ohms	1	
R26	ОЖ0.467.004 ТУ "	[illegible] 100 K-ohms-II	[illegible]	1	
R27	ОЖ0.467.004 ТУ "	[illegible] 7.5 K-ohms-II	[illegible] K-ohms	1	
R28	ОЖ0.467.004 ТУ "	[illegible] (1-47) K-ohms-II	([illegible] 47) K-ohms	1	Selected during alignment
R29	ОЖ0.467.004 ТУ "	[illegible] (27-36) ohms-II	(27 to [illegible]) ohms	1	Selected during alignment
R30	ОЖ0.467.004 ТУ "	[illegible] 100 K-ohms-I	100 K-ohms	1	
R31	ОЖ0.467.004 ТУ "	[illegible] 100 K-ohms-I	100 K-ohms	1	
R32	ОЖ0.467.004 ТУ "	[illegible] 6.8 K-ohms-II	6.8 K-ohms	1	
R33	ОЖ0.467.004 ТУ "	[illegible] 51 ohms-I	51 ohms	1	
R34	ОЖ0.467.004 ТУ "	[illegible] 3.3 K-ohms-II	3.3 K-ohms	1	

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1	2	3	4	5	6
R_{35}	ОЖО.467.004 ТУ	Resistor ВС-0.25 1 megohms-II	1 megohm	1	
R_{36}	ОЖО.467.004 ТУ	" ВС-0.5 100 K-ohms-II	100 K-ohms	1	
R_{37}	ОЖО.467.004 ТУ	" ВС-0.25 51 ohms-II	51 ohms	1	
R_{38}	ОЖО.467.004 ТУ	" ВС-0.25 360 K-ohms-II	360 K-ohms	1	
R_{39}	ОЖО.467.004 ТУ	" ВС-0.25 (100-680) ohms-II	(100 to 680) ohms	1	Selected during alignment
R_{40}	ОЖО.467.004 ТУ	" ВС-0.25 1 K-ohms-II	1 K-ohm	1	
R_{41}	ОЖО.467.004 ТУ	" ВС-0.25 270 K-ohms-II	270 K-ohms	1	
R_{42}	ОЖО.468.004 ТУ	" С-II-2-b-220-A	220 K-ohms	1	
R_{43}	ОЖО.468.004 ТУ	" ВС-0.25 (8.2-33) K-ohms-II	(8.2 to 33) K-ohms	1	Selected during alignment
R_{44}	ОЖО.467.003 ТУ	" МЛТ-1-5.6 K-ohms-II	5.6 K-ohms	1	
R_{45}	ОЖО.467.003 ТУ	" МЛТ-1-5.6 K-ohms-II	5.6 K-ohms	1	
R_{46}	ОЖО.467.007 ТУ	" ВС-0.25 (6.8-10) K-ohms-II	(6.8 to 10) K-ohms	1	
R_{47}	ОЖО.467.004 ТУ	" ВС-0.25 (330-5100) ohms-II	330 to 5100 ohms	1	Selected during alignment
R_{48}	ОЖО.467.003 ТУ	" МЛТ-1-62 K-ohms-I	62 K-ohms	1	
R_{49}	ОЖО.467.003 ТУ	" МЛТ-1-62 K-ohms-I	62 K-ohms	1	
R_{50}	ОЖО.467.004 ТУ	" ВС-0.5 51 K-ohms-I	51 K-ohms	1	
R_{51}	ОЖО.467.004 ТУ	" ВС-0.5 51 K-ohms-I	51 K-ohms	1	
R_{52}	ОЖО.467.003 ТУ	" МЛТ-1.10 K-ohms-II	10 K-ohms	1	

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	3		4	5	6
[illegible].004 TY	Resistor	[illegible]C-0.25 32 K-ohms-II	32 K-ohms	1	
[illegible].017	"	36 ohms	36 ohms	1	
[illegible].004 TY	"	[illegible]C-0.25 130 K-ohms-II	130 K-ohms	1	
[illegible].004 TY	"	[illegible]C-0.25 1.5 K-ohms-II	1.5 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 220 K-ohms-II	220 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 1.5 K-ohms-II	1.5 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.5 6.2 K-ohms-II	6.2 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.5 8.2 K-ohms-II	8.2 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 220 K-ohms-II	220 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 1.5 K-ohms-II	1.5 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.5 39 K-ohms-II	39 K-ohms	1	
[illegible].467.004 TY		[illegible]C-0.25 10 K-ohms-II	10 K-ohms	1	
[illegible].467.004 TY		[illegible]C-0.25 56 K-ohms-II	56 K-ohms	1	
[illegible].467.003 TY	"	[illegible]-0.5 2.2 K-ohms-II	2.2 K-ohms	1	
[illegible].467.004 TY		[illegible]C-0.25 10 K-ohms-II	10 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 270 K-ohms-II	270 K-ohms	1	
[illegible].467.004 TY	"	[illegible]C-0.25 (3.3-5.1)K-ohms-II	(3.3 to 5.1) K-ohms	1	Selected during alignment
ЕХ5.634.003	"	2 K-ohms	2 K-ohms	1	
[illegible]5.634.005	"	40 ohms	40 ohms	1	

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1	2	3	4	5	6
R_{72}	ОЖО.467.004ТУ	Resistor [illegible]	[illegible]	1	[illegible]
R_{73}	[illegible].634.017	" 1.7 ohms	1.7 ohms	1	
R_{74}	[illegible].634.015	" 36.5 ohms±0.5 ohms	[illegible]	1	
C_1	ОЖО.460.013ТУ	Capacitor [illegible]	[illegible]	1	
C_2	ОЖО.460.014ТУ	" КТК-[illegible]	[illegible]	1	
C_3	ГОСТ6119-54	" КСО-2-500-[illegible]	[illegible]	1	
C_4	ОЖО.460.013ТУ	" КТК-1-М-5-[illegible]	[illegible]	1	
C_5	ГОСТ6119-54	" КСО-2-500-[illegible]	[illegible]	1	
C_6	ОЖО.460.014ТУ	" КТК-1-[illegible]	[illegible]	1	
C_7	ГОСТ6119-54	" [illegible]	[illegible]	1	
C_8	ГОСТ6119-54	" [illegible]	[illegible]	1	
C_9	ОЖО.460.013ТУ	" КТК-1-[illegible]	[illegible]	1	
C_{10}	ОЖО.460.013ТУ	" КТК-1-М-30-I	[illegible]	1	
C_{11}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{12}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{13}	ГОСТ6119-54	" КСО-2-500-А-510-II	510 pF	1	
C_{14}	ГОСТ6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{15}	ГОСТ6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{16}	ГОСТ6119-54	" КСО-2-500-А-1000-III	1000 pF	1	
C_{17}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{18}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{19}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{20}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{21}	ГОСТ6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{22}	ГОСТ6119-54	" КСО-5-500-А-6800-III	6800 pF	1	
C_{23}	ГОСТ6119-54	" КСО-2-500-А-1000-III	1000 pF	1	
C_{24}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{25}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{26}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{27}	ОЖО.460.013ТУ	" КТК-1-М-30-I	30 pF	1	
C_{28}	ГОСТ6119-54	" КСО-5-500-А-6800-III	6800 pF	1	

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1	2	3	4	5	6
C_{29}	[illegible].460.014ТУ Capacitor	КТК-1-Д-100-II	100 pF	1	
C_{30}	[illegible]6118-52 "	КБГ-МП-3В-600-2 x0.1-II	0.1 mF	0.5	In common can with C_{75}
C_{31}	[illegible].460.014ТУ "	КТК-1-Д-51-II	51 pF	1	
C_{32}	[illegible].462.022ТУ "	МБГП-3-160-2x 0.5-II-Б	0.5 mF	0.5	In common can with C_{33}
C_{33}	[illegible].462.022ТУ "	МБГП-3-160-2x 0.5-II-Б	0.5 mF	0.5	In common can with C_{32}
C_{34}	ГОСТ6119-54 "	КСО-2-500-А-100-II	100 pF	1	
C_{35}	ГОСТ6119-54 "	КСО-2-500-А-510-II	510 pF	1	
C_{36}	ГОСТ6119-54 "	КСО-5-500-А-6200-I	6200 pF	1	
C_{37}	ГОСТ6119-54 "	КСО-5-250-А-9100-I	9100 pF	1	
C_{38}	ГОСТ6119-54 "	КСО-5-500-А-3000-I	3000 pF	1	
C_{39}	ОЖО.462.022ТУ "	МБГП-3-160-2x0.5-II-Б	0.5 mF	0.5	In common can with C_{47}
C_{40}	ГОСТ6119-54 "	КСО-5-500-А-2000-II	2000 pF	1	
C_{41}	ГОСТ6119-54 "	КСО-5-500-А-2000-II	2000 pF	1	
C_{42}	ГОСТ6119-54 "	КСО-5-250-А-10000-II	10000 pF	1	
C_{43}	ГОСТ6118-52 "	КБГ-М2-200-0.07-II	0.07 mF	1	
C_{44}	ГОСТ6118-52 "	КБГ-М2-200-0.07-II	0.07 mF	1	
C_{45}	ОЖО.462.022ТУ "	МБГП-1-200-0.5-II-Б	0.5 mF	1	
C_{46}	ОЖО.464.006ТУ "	КЭГ-1- -300-5-ohms	5 mF	1	
C_{47}	ОЖО.462.022ТУ "	МБГП-3-160-2x0.5-II-Б	0.5 mG	0.5	In common can with C_{39}
C_{48}	ОЖО.464.006ТУ "	КЭГ-1-В-20-50-ohms	50 mF	1	
C_{49}	ОЖО.464.006ТУ "	КЭГ-1- -300-5-ohms	5 mF	1	
C_{50}	ОЖО.462.022ТУ "	МБГП-1-160-15-II-А	15 mF	1	

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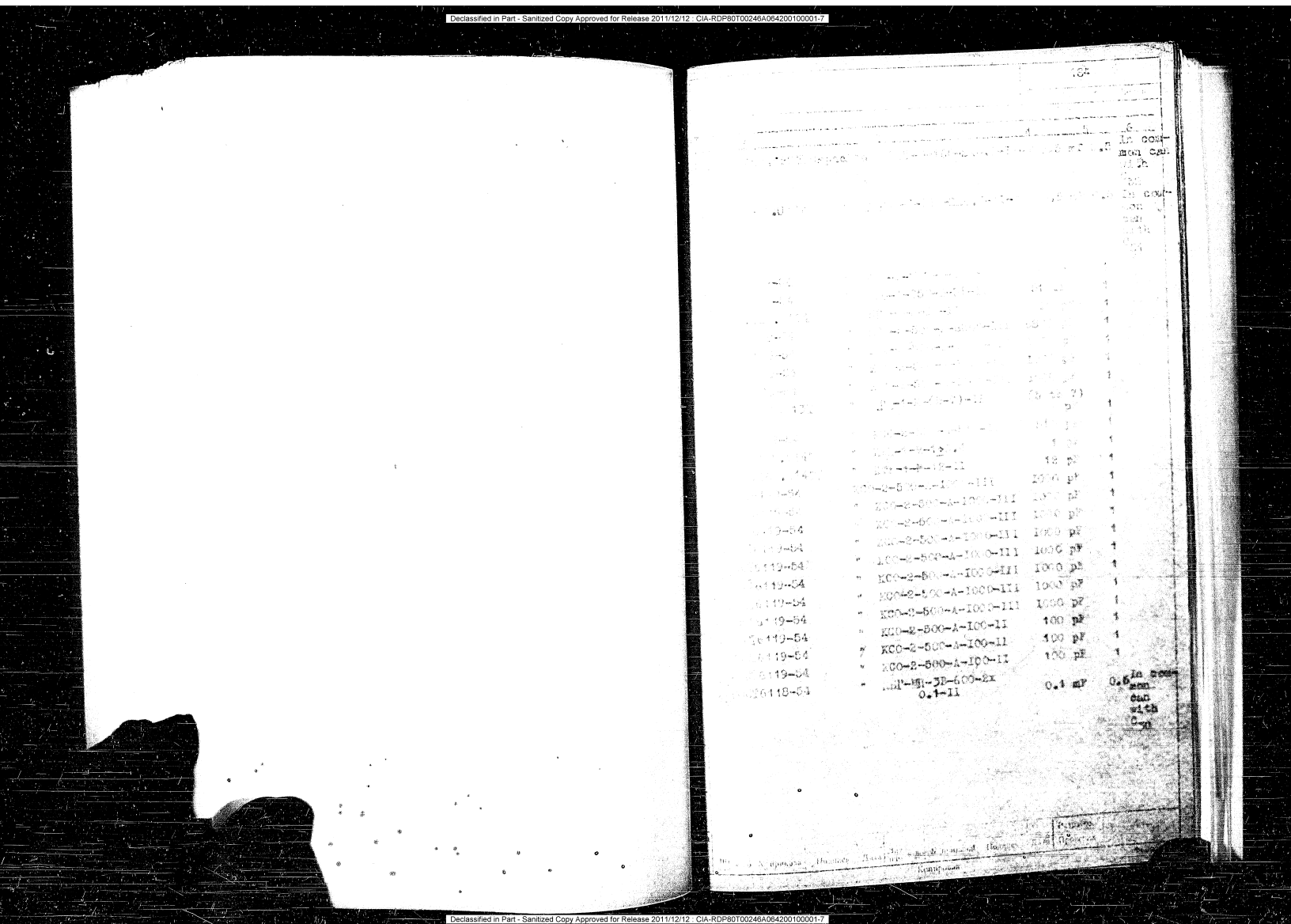

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1	2		3			
C_{76}	[illegible].462.022TV	Capacitor	[illegible]			[illegible]
C_{77}	[illegible].462.022TV	"	[illegible]	[illegible]		[illegible]
C_{78}	[illegible].460.014TV	"	[illegible]	51 p	1	
C_{79}	[illegible]6119-54	"	[illegible]	1000 p	1	
C_{80}	[illegible]6119-54	"	[illegible]	[illegible]	1	
C_{81}	[illegible].460.014TV	"	[illegible]	[illegible]	1	
C_{82}	[illegible].460.014TV	"	[illegible]	[illegible]	1	
C_{83}	[illegible].464.006TV	"	[illegible]	[illegible]		
C_{84}	[illegible].464.006TV	"	[illegible]	[illegible]		
C_{85}	[illegible].460.014TV	"	[illegible]	[illegible]		
C_{86}	[illegible]6119-54	"	[illegible]	[illegible]		
C_{87}	[illegible]6119-54	"	[illegible]	[illegible]		
C_{88}	[illegible].460.014TV	"	[illegible]	[illegible]	1	
C_{89}	[illegible]6119-54	"	[illegible]	[illegible]	1	
C_{90}	[illegible].460.014TV	"	[illegible]	51 p	1	
C_{91}	[illegible].460.014TV	"	[illegible]	1 p	1	
C_{92}	[illegible]6119-54	"	[illegible]	(1500 to 2400) pF	1	[illegible]
L_1	[illegible].062.010	Antenna coil			1	
L_2	[illegible].062.010	Input tuned circuit coil			1	
L_3	[illegible].062.017	RF tuned circuit anode coil			1	
L_4	[illegible].062.017	RF tuned circuit grid coil			1	
L_5	[illegible].067.001СП	1st IF filter coil (anode)			1	
L_6	[illegible].067.001СП	1st IF filter coil (grid)			1	
L_7	[illegible].067.001СП	2nd IF filter coil (anode)			1	
L_8	[illegible].067.001СП	2nd IF filter coil (grid)			1	
L_9	[illegible].067.002СП	3rd IF filter coil (anode)			1	
L_{10}	[illegible].067.002СП	3rd IF filter coil (grid)			1	

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L_{11}	[illegible].062.001CH	7.5 Kc/s coil of discriminator tuned circuit	1	
L_{12}	[illegible].062.001CH	10 Kc/s coil of discriminator tuned circuit	1	
L_{13}	[illegible].062.001CH	12.5 Kc/s coil of discriminator tuned circuit	1	
L_{14}	[illegible].062.002	1st harmonic tuned circuit	1	
L_{15}	[illegible].062.013	Coil of 1st frequency multiplication tuned circuit	1	
L_{16}	[illegible].062.015	Coil of 2nd frequency multiplication tuned circuit (anode)	1	
L_{17}	[illegible].062.015	Coil of 2nd frequency multiplication tuned circuit (grid)	1	
L_{18}	[illegible].062.017	Coil of 3rd frequency multiplication tuned circuit (anode)	1	
L_{19}	[illegible].062.017	Coil of 3rd frequency multiplication tuned circuit (grid)	1	
L_{20}	[illegible].062.002CH	Coupling coil of bias generator	1	
L_{21}	[illegible].062.002CH	Tuned circuit coil of bias generator	1	
V_1	TC3.300.004 TY	Type 6Ж1П valve	1	
V_2	TC3.300.004TY	Type 6Ж1П valve	1	
V_3	BTY01.123-84	Type 6Ж4П valve	1	
V_4	BTY01.123-84	Type 6Ж4П valve	1	
V_5	TC3.303.001TY	Type 6Ж2П valve	1	
V_6	TC3.301.006TY	Type 6Ж2П valve	1	
V_7	TC3.303.001TY	Type 6Ж2П valve	1	
V_8	TC3.301.006TY	Type 6Ж2П valve	1	
V_9	TC3.301.000TY	Type 6Н3П valve	1	
V_{10}	TC3.301.000TY	Type 6Н3П valve	1	
V_{11}	TC3.301.000TY	Type 6Н3П valve	1	
V_{12}	TC3.300.004TY	Type 6Ж1П valve	1	
V_{13}	TC3.301.000TY	Type 6Н3П valve	1	
Tr_1	EX4.731.002 CH	Variable phase transformer	1	
Ch_1	EX4.750.001CH	Supply choke	1	
Cr_1		Crystal I	1	
Cr_2		Crystal II	1	

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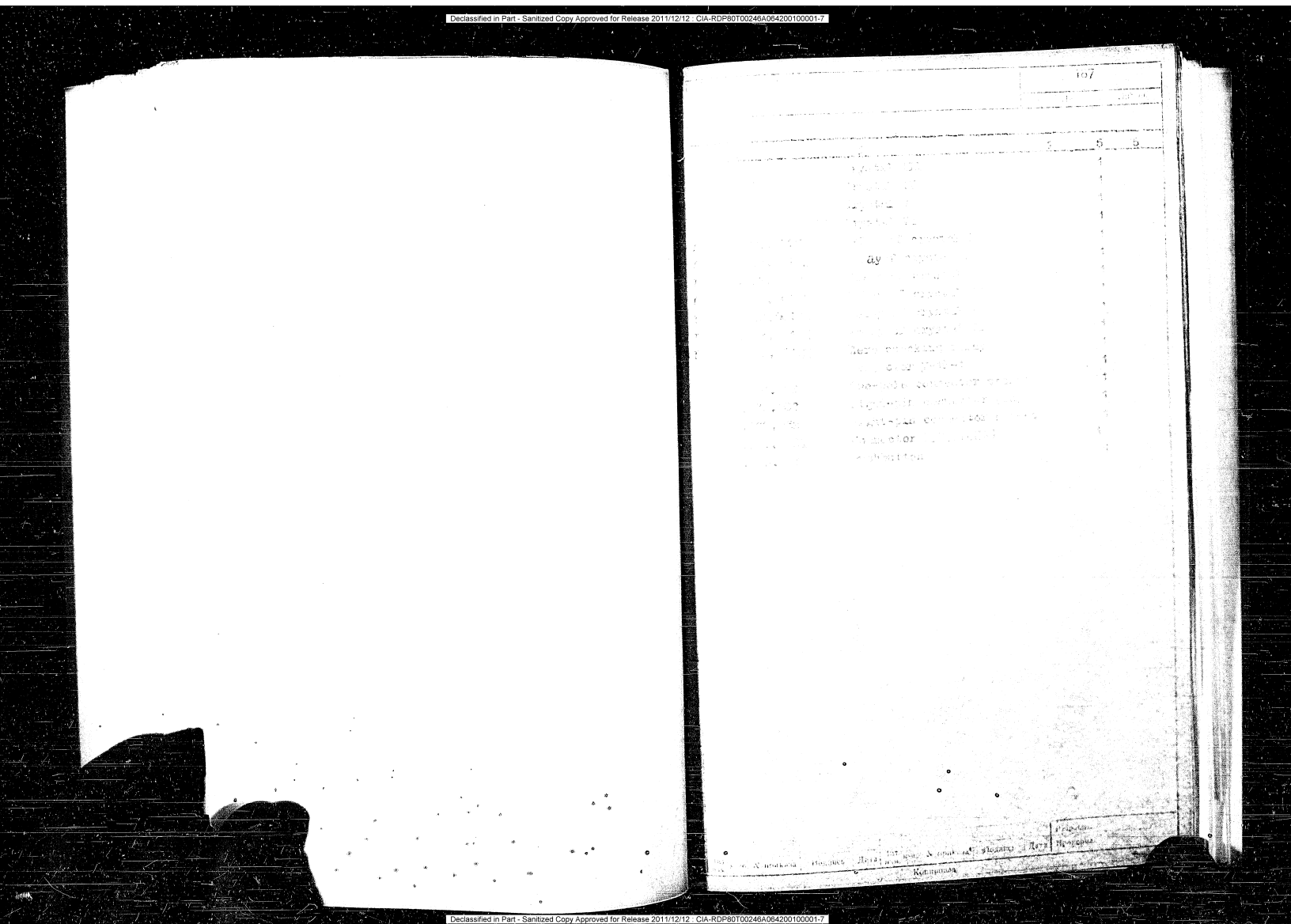

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Sheet No. [illegible]

LIST OF PARTS FOR AMPLITUDE [illegible]

Circuit	U.S.S.R. Standard Specif., drawing No.	Description and type	Main rating	Quantity	Note
1	2	3	4	5	6
R_1	ОХ0.467.003ТУ	Resistor МЛТ-0.5(86-360) K-ohms-II	(86 to 360) K-ohms	1	Selected during alignment
R_2	ОХ0.468.004ТУ	" СП-II-26-150 K-ohms-A	150 K-ohms	1	
R_3	ОХ0.467.003ТУ	" МЛТ-0.5-1 K-ohms-II	1 K-ohms	1	
R_4	ОХ0.467.003ТУ	" МЛТ-0.5-1 K-ohms-II	1 K-ohms	1	
R_5	ОХ0.468.004ТУ	" СП-II-26-2200 ohms	[illegible]	1	
R_6	ОХ0.467.003ТУ	" МЛТ-0.5-1 K-ohms-II	1 K-ohms	1	
R_7	ОХ0.467.003ТУ	" МЛТ-0.5-1 K-ohms-II	1 K-ohms	1	
R_8	ОХ0.467.011ТУ	" ПДВ-15х--100 ohms	[illegible] ohms	1	
R_{11}	ОХ0.467.003ТУ	" МЛТ-0.5-1 K-ohms-II	1 K-ohms	1	
R_{12}	ОХ0.467.003ТУ	" МЛТ-0.5-(12-20) K-ohms-II	(12 to 20) K-ohms	1	Selected during alignment
C_1	ОХ0.468.02ТУ	Capacitor МБГП-2-200-0.5-II-A	0.5 pF	1	
C_2	ОХ0.464.001ТУ	" ЭГП-20-50-ohms	50 mA	1	
C_3	ГОСТ 6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
C_4a	ГОСТ6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
C_4b	ГОСТ6119-54	" КСО-5-500-В-6200-II	6200 pF	1	
C_5	ГОСТ6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
C_6	ГОСТ6119-54	" КСО-5-500-В-3900-II	3900 pF	1	
C_7	ГОСТ6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
C_8	ГОСТ6119-54	" КСО-5-500-В-6200-II	6800 pF	1	
C_9	ГОСТ6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
C_{10}	ГОСТ6119-54	" КСО-5-250-В-10000-II	10000 pF	1	
V_1	ТС3.301.000ТУ	Type 6Н3П valve		1	
Tr_1	ЕЖ 2.067.006 СП	Transformer, 150 c/s		1	
Tr_2	ЕЖ 2.067.005 СП	Transformer, 90 c/s		1	
J_1	ЕЖ 6.604.014	Jack		1	

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1	2	3	4	5	6
[illegible]	[illegible].700.002СП	Anode choke		1	
[illegible]	[illegible].067.006СП	Filter choke, 160 c/s		1	
[illegible]	[illegible].067.006СП	Filter choke, 160 c/s		1	
[illegible]	[illegible].067.005СП	Filter choke, 90 c/s		1	
[illegible]	[illegible].067.005СП	Filter choke, 90 c/s		1	
[illegible]	[illegible].211.133ТУ	Copper-oxide rectifier АВК-II		1	
[illegible]	[illegible].523.009ТУ	Relay, type РОС-6		1	
[illegible]	[illegible].523.009ТУ	Relay, type РОС-6		1	
[illegible]	[illegible].523.009ТУ	Relay, type РОС-6		1	
[illegible]	[illegible].364.002ТУ	Connector [illegible]		1	

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Appendix No. 4

LIST OF PARTS OF THE CAPACITORS UNIT

Circuit Symbol	U.S.S.R. Standard, Specif., Drawing No.	Description and type	Main rating	Quantity	Note
1	2	3	4	5	6
[illegible]	[illegible].464.001TY	Capacitor ЭГП-6- $\frac{20}{1000}$	ohms 1000 mF	1	
[illegible]	[illegible].464.001TY	Capacitor ЭГП-6- $\frac{20}{500}$	ohms 500 mF	1	
[illegible]	[illegible].[illegible]3.009TY	Relay, type РЭС-6		1	
[illegible]	[illegible].523.009TY	Relay, type РЭС-6		1	
[illegible]	[illegible].364.002TY	Connector ШР32Н14НШ5		1	

Appendix No. 5

LIST OF PARTS OF THE CONTROL PANEL, MODIFIED FOR THE "ILS" SYSTEM

Circuit Symbol	U.S.S.R. Standard, Specific., Drawing No.	Description and type	Main rating	Quantity	Note
[illegible]	[illegible].634.005	Resistor 40 ohms	40 ohms	1	
[illegible]	[illegible].467.004TY	" ВС-0.25.-6.2 К-ohms-I	6.2 К-ohms	1	
[illegible]	[illegible].467.004TY	" ВС-0.25-6.2 К-ohms-I	6.2 К-ohms	1	
[illegible]	[illegible].468.004TY	" СП-1-26-1500-А-4	1500 ohms	1	
[illegible]	[illegible].640.002	Zero checking pushbutton		1	
[illegible]	[illegible].618.009	Six-positioned switch		1	
[illegible]	[illegible].360.606	Toggle switch ТП-1-2		1	
[illegible]	[illegible].360.606	Toggle switch ТВ-2-1		1	
[illegible]	[illegible].364.002TY	Connector ШР32Н14НШ5		1	

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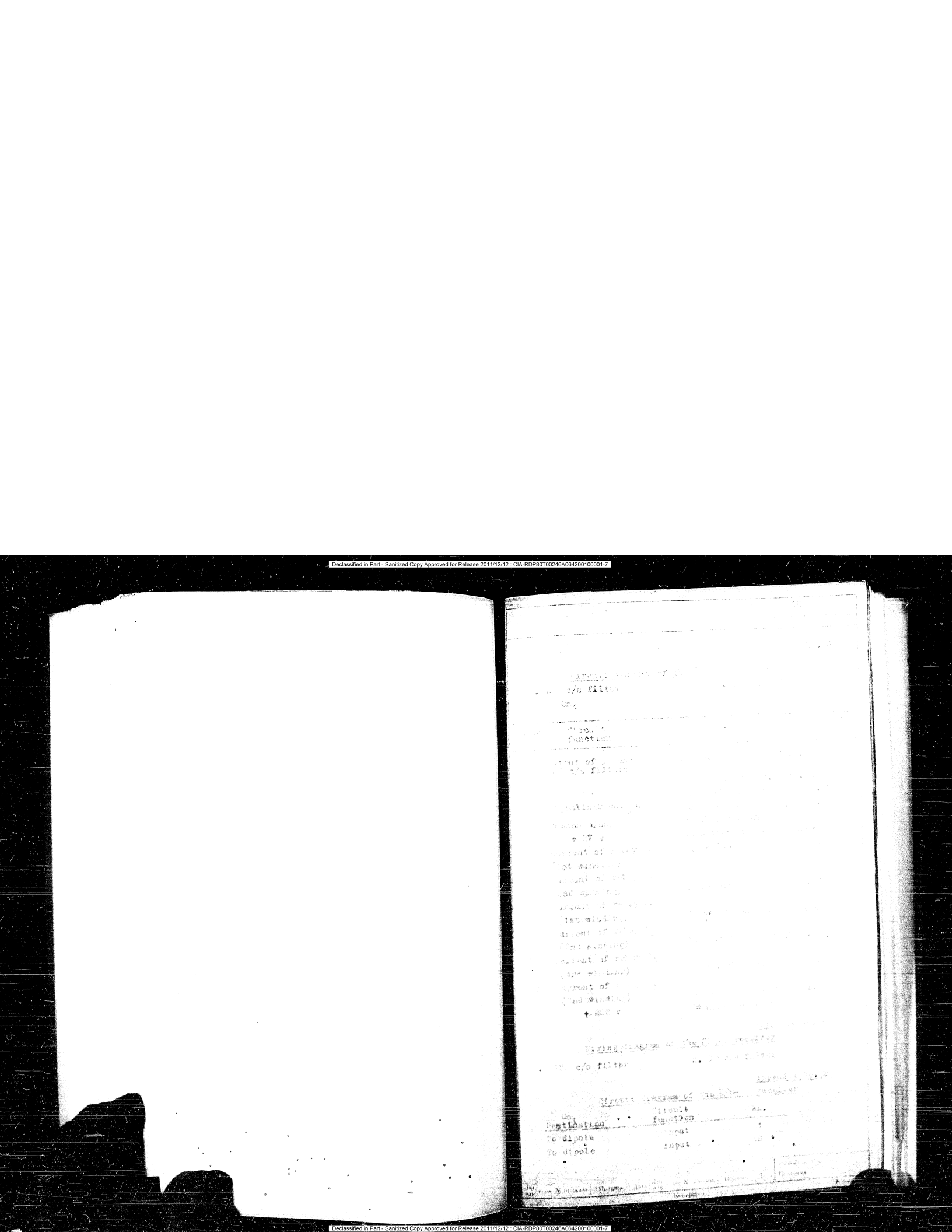

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Contact No.	Circuit function	Destination
1	Common	To 27 v network
3	-	To HCH-48 indicator, term. 3
10	Output of phase detector	To HCH-48 indicator, term. 1 to control panel, term. 14
6	Signalizer current	To HCH-48 indicator, term. 2
13	Output of phase detector	To HCH-48 indicator, term. 4 to control panel, term. 13
12	Current of relay P_7	To pushbutton on control panel
9	+ 27 v	To switch on control panel
5	Current of relay P_1	To switch on control panel
2	Current of relay P_2	To switch on control panel
4	Current of relay P_3	To switch on control panel
7	Current of relay P_4	To switch on control panel
11	Current of relay P_5	To switch on control panel
8	Current of relay P_6	To switch on control panel

Appendix No. 9

Wiring diagram of the KPH-2 receiver

1. Top view of panel
2. Bottom view of panel

Appendix No. 10

Circuit diagram of the amplitude attachment

1. Sensitivity to ILS 2. 150 c/s filter 3. 90 c/s filter 4. "0" balance" to ILS

No.	Circuit function	Destination
1.	Signal input	To KPH-2, term. 3
2.	+ 27 v	To control panel, term. 10
3.	From KPH-2	To KPH-2, term. 13
4.	Signalizer current, KPH-2	To HCH-48, term. 2
5.	HCH-48, KPH-2	To HCH-48, term. 1
6.	HCH-48, KPH-2	To HCH-48, term. 4

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11. Relay. 12. Course. 13. Glide-slope. [illegible]
15. Distribution box. 16. Control [illegible]
18. Course. 19. Signalizer. 20. [illegible]
indicator. 22. Signal lamp.

Connection diagram for [illegible]
"[illegible]" system

[illegible] Distribution box. [illegible]
[illegible] 6. [illegible] indicator. [illegible]

Connection diagram of capacitor [illegible]
system

[illegible] Distribution box. [illegible]

Diagram of cable [illegible]
system

[illegible] of [illegible]
[illegible] of [illegible]
[illegible] 6. Crystal relay. 7. [illegible]
[illegible] checking relay. [illegible]
[illegible] 15. Relay. 1[illegible]
[illegible] Course. 16. Glide-slope. [illegible]
[illegible] 19. Distribution box. [illegible]
[illegible] 23. Amplitude attachment. [illegible]
25. Signal input. 26. [illegible] of [illegible]
28. Common - 29. [illegible] of [illegible] 30. [illegible]
from [illegible]. 32. [illegible] of [illegible]
signalizer. 34. [illegible] of [illegible]
[illegible]lizer. 37. Course. [illegible] Signalizer. [illegible]
[illegible] indicator. [illegible]

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Appendix No. 16

Connection diagram of two ЦСП-48 indicators in "МЦС" system

1. Distribution box. 2. 1st indicator. 3. Course. 4. Glide-slope. 5. 2nd indicator.

Appendix No. 17

Circuit diagram of modifications of the [illegible] receiver for operation in the "МЦС" system

1. N o t e : This diagram includes only that part of the receiver circuit where modifications have to be made (shown in thick lines).

Cn_4

Pin No.	Circuit function	Destination
1	Common minus	To 27 v network
3	Signal output	To amplitude attachment, term. 1
13	Output of phase detector	To amplitude attachment, term. 10
6	Signalizer current	To amplitude attachment, term. 11
10	Output of phase detector	To amplitude attachment, term. 8
12	Current of relay P_7	To pushbutton on control panel
9	+ 27 v	To control panel, term. 3
5	Current of relay P_1	To switch on control panel, term. 5.
2	Current of relay P_2	To switch on control panel, term. 2.
4	Current of relay P_3	To switch on control panel, term. 4.
7	Current of relay P_4	To switch on control panel, term. 7
11	Current of relay P_5	To switch on control panel, term. 11
8	Current of relay P_6	To switch on control panel, term. 8
14	+ 200 v	To amplitude attachment, term. 7

Лит. изм. | к-во | № приказа | Подпись | Дата | Лит. изм. | к-во | № приказа | Подпись | Дата | Разработ. | Проверил

Контроль

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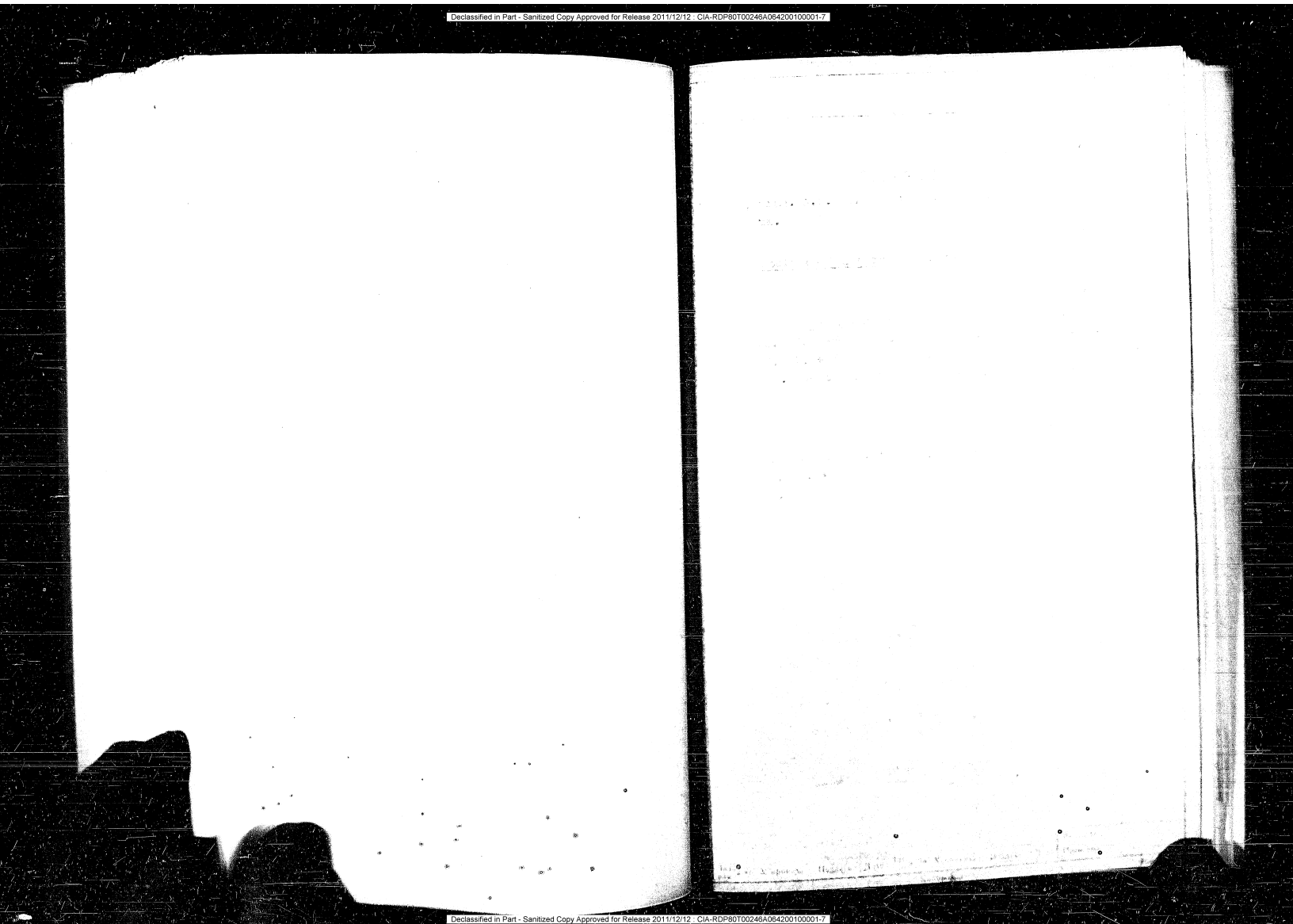

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FIGURES

Fig. 1

Fig. 2

Fig. 3 Directivity pattern of the glide-slope radio beacon antenna in the "[illegible]" system.

1. Directional radiation lobes of glide-slope radio beacon antenna. 2. Equisignal zone. 3. Antenna of glide-slope radio beacon. 4. Landing strip.

Fig. 4

1. Undirectional radiation 2. Directional radiation.

Fig. 5

Fig. 6

1. Input circuit 2. Mixer 6[illegible] 3. Intermediate frequency amplifier, 3 stages 6[illegible] 4. Detector 5. Audio frequency amplifier 6[illegible] 6. A.G.C. rectifier 7. Local oscillator [illegible] oscillator and 5 frequency multiplication [illegible] 6[illegible] 8. 150 c/s filter. 9. 90 c/s filter.

Fig. 7

1. Audio frequency amplifier output 2. 90 c/s filter 3. Copper-oxide bridge 4. Signalizer winding. 5. Indicator winding. 6. 150 c/s filter 7. Copper-oxide bridge.

Fig. 8

1. Copper-oxide bridge 2. Emergency signalizer winding 3. Glide-slope indicator winding

Fig. 9

1. 60 c/s pre-amplifier 6[illegible] 2. Variable phase output amplifier 6H3П 3. Audio frequency amplifier 6[illegible] 4. Mixer 6[illegible] 5. Intermediate frequency amplifier 6K4П 6. Second detector and A.G.C. rectifier 6[illegible] 7. Phase detector 6[illegible] 8. КСП-48 indicator 9. 10 Kc/s and A.G.C. amplifier 6[illegible] 10. Kc/s amplifier 6H2П 11. Constant-phase output amplifier 6[illegible] 12. Local oscillator 6H3П , 6[illegible] 13. Bias and A.G.C. generator 6H3П 14. Limiter 6H2П 15. Discriminator 6[illegible]

Fig. 10

1. From КРП-Ф 2. Audio frequency amplifier 3. 90 c/s filter 4. 150 c/s filter 5. Rectifier 6. Signalizer current

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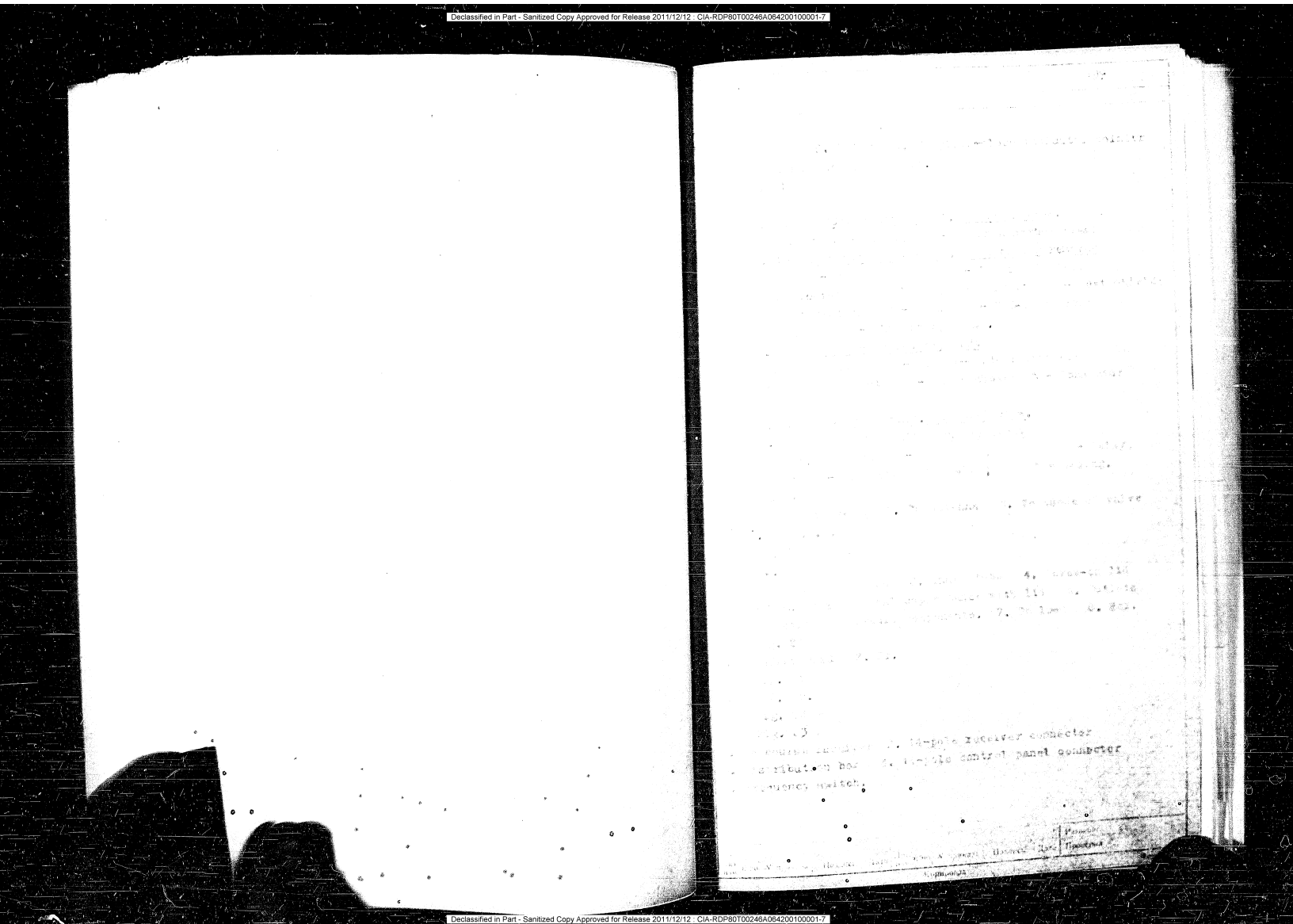

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Fig. 24

1. 2nd IF filter 2. 3rd IF filter [illegible]

4. To detector anode (V_5, pin 7) [illegible]

(V_5, pin 8) 6. To A.G.C.

Fig. 25

1. To anode 2. To grid [illegible]

Fig. 26

Fig. 27

1. Meter jack 2. To grids of intermediate frequency amplifier

Fig. 28

1. Current of A.G.C. rectifier 2. Meter switch

3. Current of valve V_6.

Fig. 29

Fig. 30

1. S/S.

Fig. 31

1. CM_1 2. A.G.C. 3. From local oscillator

Fig. 32

1. To grid of GEAR valve 2. From local oscillator [illegible]

Fig. 33

1. To mixer (V_2) 2. Cr.

Fig. 34

Fig. 35

1. A.G.C.

Fig. 36

1. To Yth pin of V_8 2. To 2nd pin of V_6 [illegible]

rator.

Fig. 37

1. To 1st grid of V_1 2. To 1st grid of V_3 3. To 1st grid of V_4.

Fig. 38

1. To cathode of V_5 2. To grids of control valves

Fig. 39

1. From anode of V_6

Fig. 40

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Fig. 41

1. U_{out} (volts) 2. U_{in} (volts)

Fig. 42

1. To 7th pin of V_9

Fig. 43

1. Kc/s

Fig. 44

Fig. 45

Fig. 46

Fig. 47

1. From discr.

Fig. 48

1. From detector load

Fig. 49

1. To anode 2. Balance 3. Course.

Fig. 50

Fig. 51

Fig. 52

Fig. 53. RPM-2 receiver. View from valve side

1. 90 c/s filter; 2 - 150 c/s filter; 3 - Supply choke; 4 - Anode choke; 5 - Capacitors C_{80}, C_{81}; 6 - Dynamotor V-18-I ; 7 - Crystals; 8 - Antenna receptacle; 9 - Coaxial tuned circuits; 10 - "Earth" binding post; 11 - 1st intermediate filter; 12 - Lid "adjustment"; 13 - Potentiometer R_{82}; 14 - 2nd intermediate frequency filter; 15 - 3rd intermediate frequency filter; 16 - 4th intermediate frequency filter.

Fig. 54. RPM-2 radio receiver. View from circuitry side

1 - Capacitor C_{36}; 2 - Strip with resistors; 3 - Capacitor C_{38}; 4 - ABK-2 copper-oxide rectifier bridges; 5 - Strip with resistors; 6 - Supply connector; 7 - "Tester" jack; 8 - Coaxial tuned circuits; 9 - RF relays; 10 - Strip with capacitors; 11 - Dynamotor V-18-I ; 12 - RF choke.

Fig. 55. RPM-2 receiver. View from valve side

1 - Tuned circuit of bias rectifier; 2 - 7 - Crystals; 8 - "Earth" binding post; 9 - 1st IF filter; 10 - Lid

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...tuent"; 11 - Capacitor C_{38}; 12 - Sec IF filter; 13 - ...minator; 14 - 3rd IF filter; 15 - Variable phase ...former; 16 - Supply choke; 17 - Dynamotor V-18-1.

Fig. 56. RPH-2 receiver. View from circuitry side

1 - Dynamotor V-18-1; 2 - 7 RF relays P_1 - P_6; 8 - Antenna receptacle; 9 - "Checking" pushbutton; 10 - RF relay P_7; 11 - Supply receptacle; 12 - Capacitor C_{46}; 13 - Capacitor ...

Fig. 57

1. Antenna 2. Screw-upright 3. Feeder

Fig. 58

Fig. 59

1. RV 2. LV 3. Common -

Fig. 60

R_c - Course indicator coil;

R_g - Glide-slope indicator coil;

R_{cs} - Course signalizer coil;

R_s - Series resistor coils;

R_{gs} - Glide-slope signalizer coil

Fig. 61

Fig. 62

Fig. 63

1. 6-way switch 2. Switch 3. Sw_1 4. Ohms 5. X-ohms 6. Connector 7. Pb.

Fig. 64

Fig. 65

Fig. 66

Fig. 67

1. 8 holes diam. 4.5

Fig. 68

1. Blue 2. Yellow 3. Yellow space (phase 0°) 4. Blue space (phase 180°) 5. Course beacon 6. Landing strip 7. Landing course

Fig. 69

1. a) Block diagram for measuring sensitivity 2. Signal generator, type ГСК-2 3. To input 4. ГРН-2 receiver 5. ИСН-48 output indicator 6. Audio generator type ЗГ-2А

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7, 8) Block diagram for measuring [illegible] frequency amplifier. 1) [illegible] circuit L_2 C_2 2) [illegible] 3. Standard signal generator [illegible] 4. [illegible]-48 output indicator. 5. Audio generator [illegible] 6) Block diagram for measuring [illegible] 13. [illegible] generator [illegible] ГСК-2 14. To input 15. [illegible] electrometer with scale of [illegible] 17. Audio generator [illegible] ЗГ-2А.

Fig. 70. Block diagram for connecting measuring equipment and measuring electrical parameters of receivers.

1. Block diagram for measuring sensitivity and [illegible] 2. Block diagram for measuring bandwidth of intermediate frequency amplifier. 3. Block diagram for measuring [illegible] characteristics 4. Signal generator ЗГ-[illegible] 5. To receiver input 6. КРП-[illegible] receiver 7. To pin 3 or 7 of valve V_{1A} 8. Output meter, [illegible] 9. Audio generator ЗГ-[illegible] 10. Standard signal generator ГСС-5 11. To 1st pin of valve V_{1} 12. [illegible] receiver 13. To pin 3 or 7 of valve V_{1} 14. Output meter, [illegible] 15. Audio generator ЗГ-2А 16. Standard signal generator ГСС-6 17. To 1st pin of valve V_9 18. [illegible] receiver 19. To 5th pin of valve V_7. 20. Valve voltmeter [illegible] 21. Audio generator ЗГ-2А

Fig. 71

1 Input of signal
2 + 27 volts
3 From КРП-[illegible]
4 Signalizer current, КРП-[illegible]
5 To [illegible]-48 , КРП-[illegible]
6 To [illegible]-48 , КРП-[illegible]
7 + 200 V
8 From КРП-[illegible]
9 Earth
10 From КРП-[illegible]

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11. Signalizer current.

12. From
13. To ,
14. To ,

15. Course 16. Signalizer 17. Glide-slope 18. Microswitch
19. 72.

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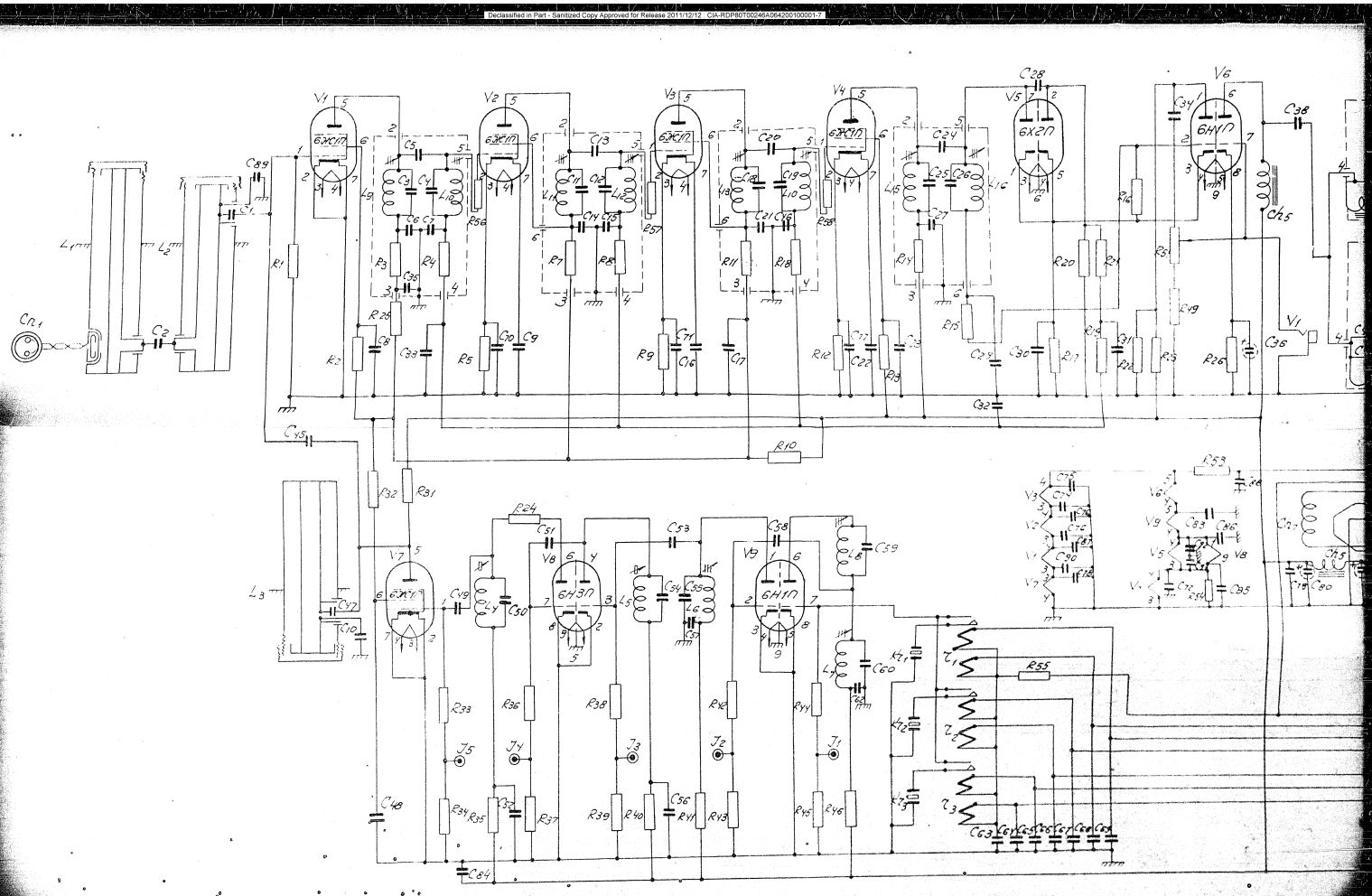

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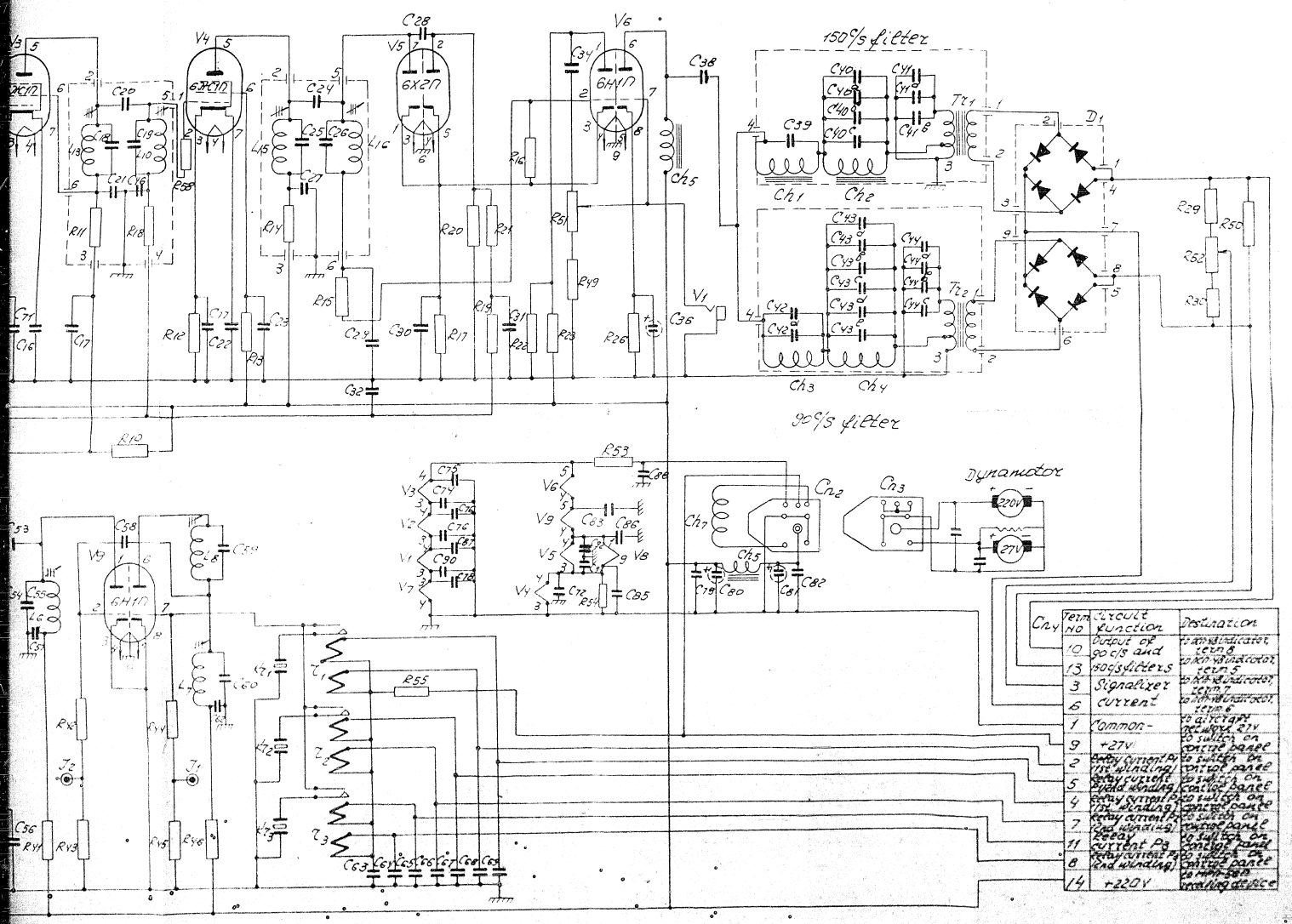

Term No	Circuit function	Destination
10	Output of 90 c/s and 150 c/s filters	to PCM-48 indicator, term 8
13		to PCM-48 indicator, term 5
3	Signalizer current	to PCM-48 indicator, term 7
6		to PCM-48 indicator, term 6
1	Common-	to aircraft network 27V
9	+27V	to switch on control panel
2	Relay current P1 (1st winding)	to switch on control panel
5	Relay current P1 (2nd winding)	to switch on control panel
4	Relay current P2 (1st winding)	to switch on control panel
7	Relay current P2 (2nd winding)	to switch on control panel
11	Relay current P3	to switch on control panel
8	Relay current P3 (2nd winding)	to switch on control panel
14	+220V	to MPA-58P receiving device

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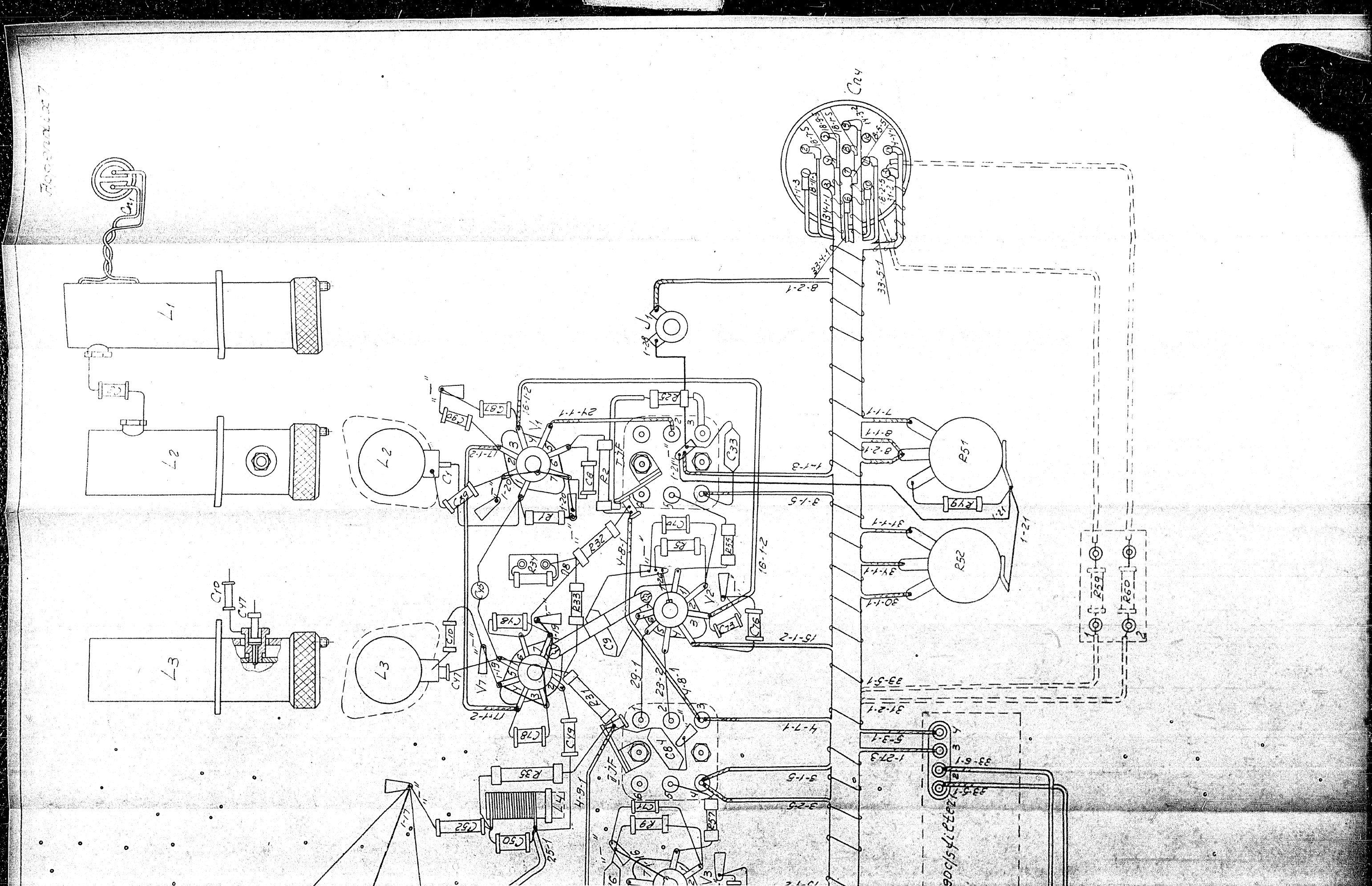

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Wiring diagram of MR-2 receiver

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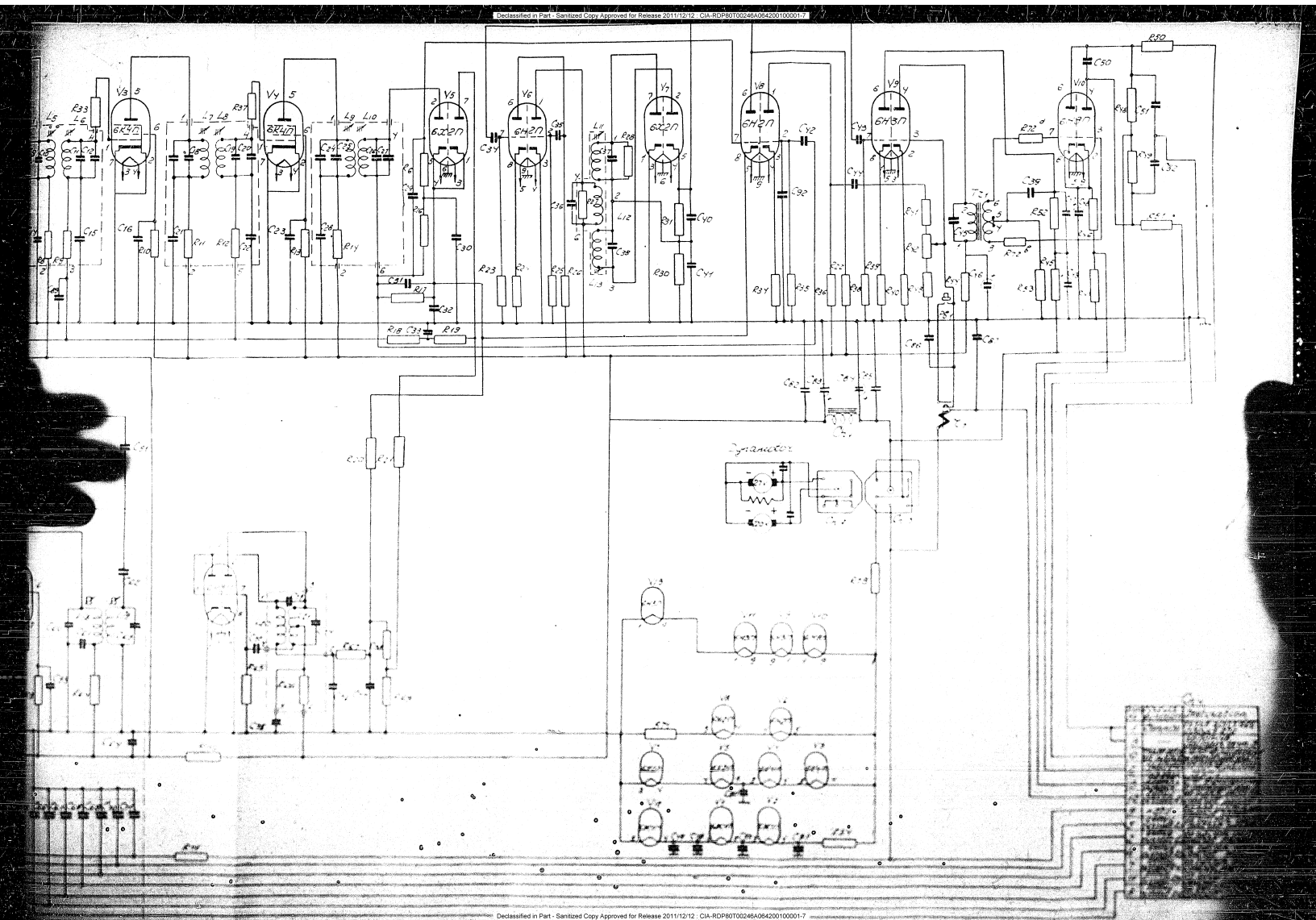

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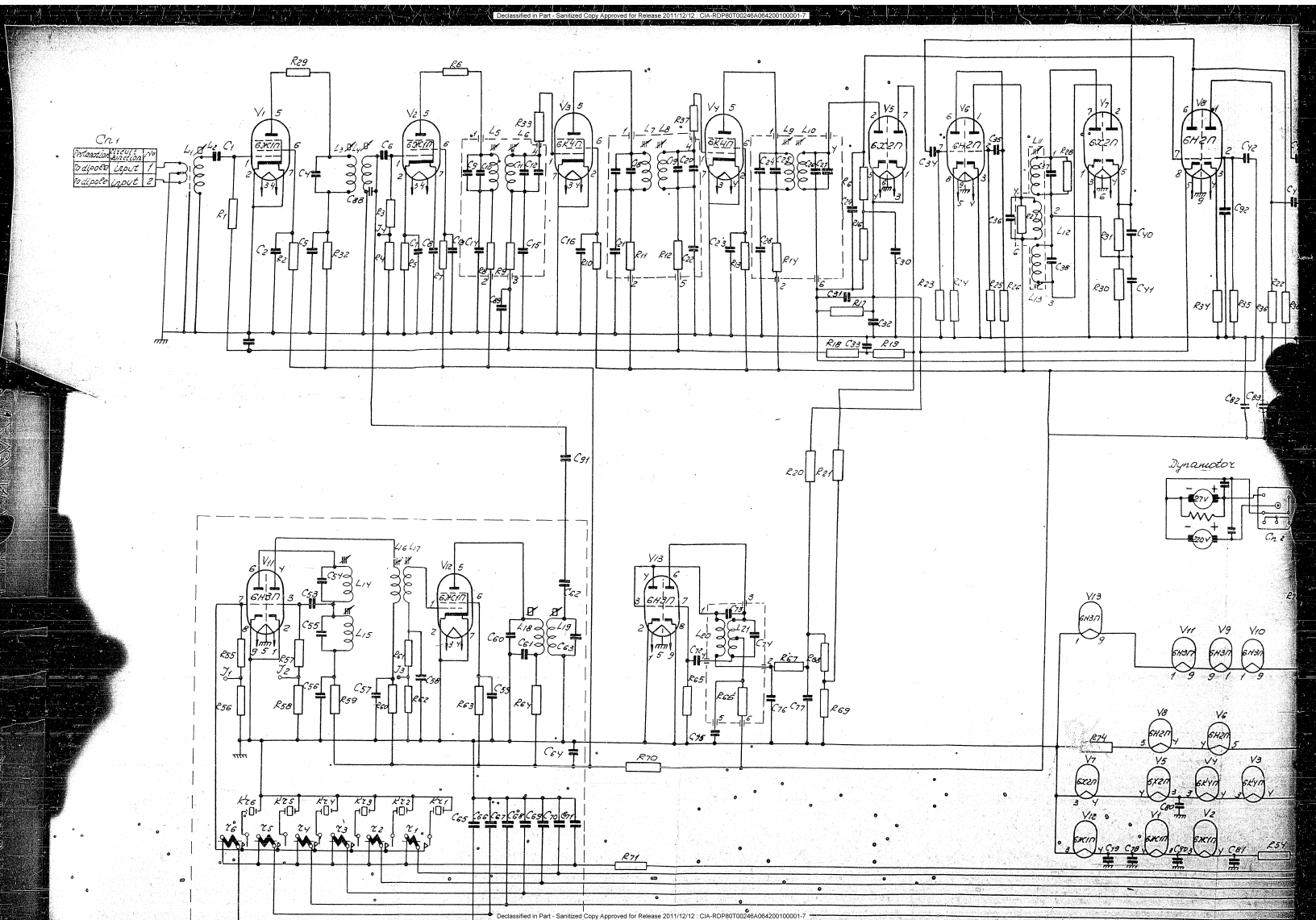

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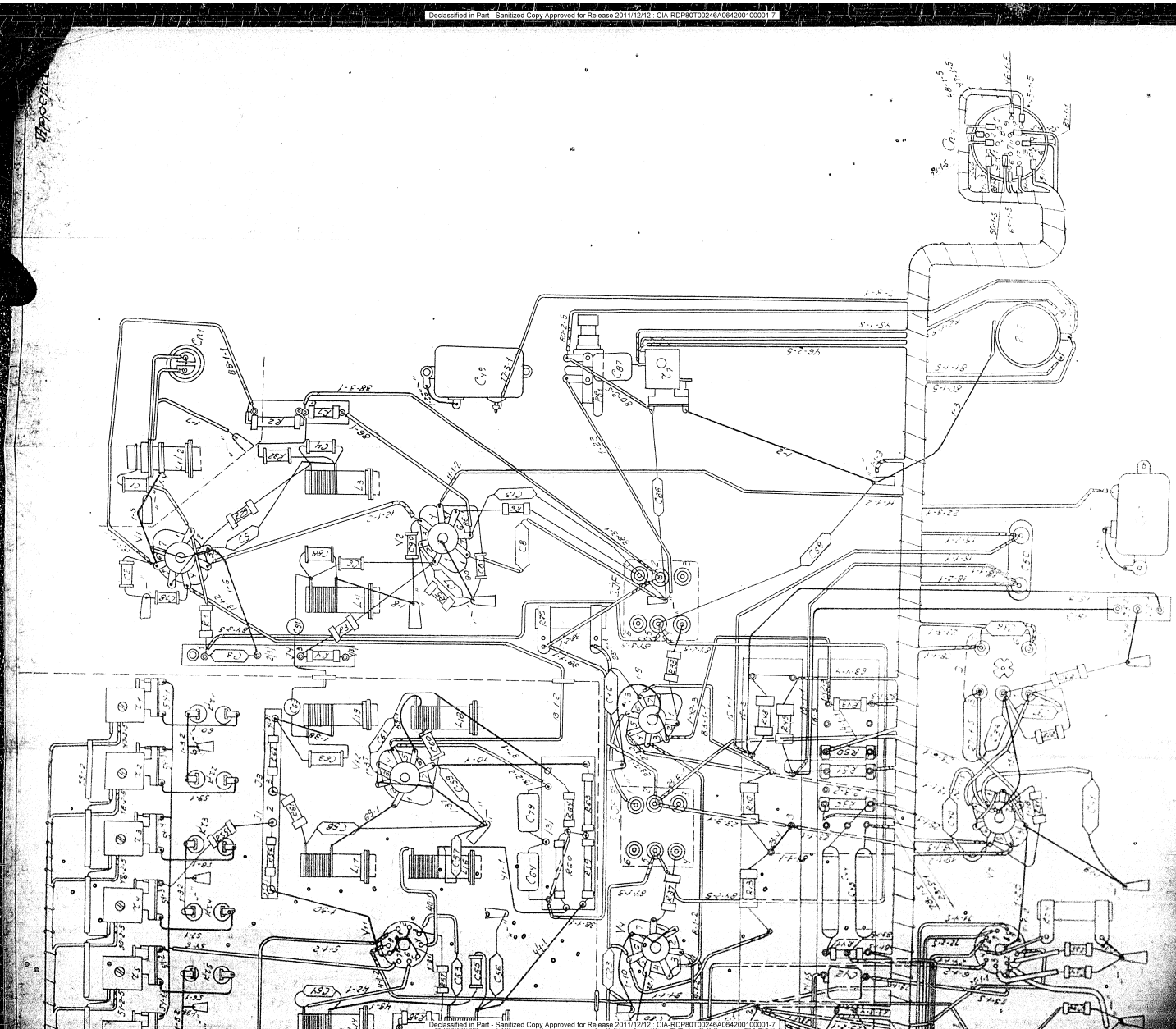

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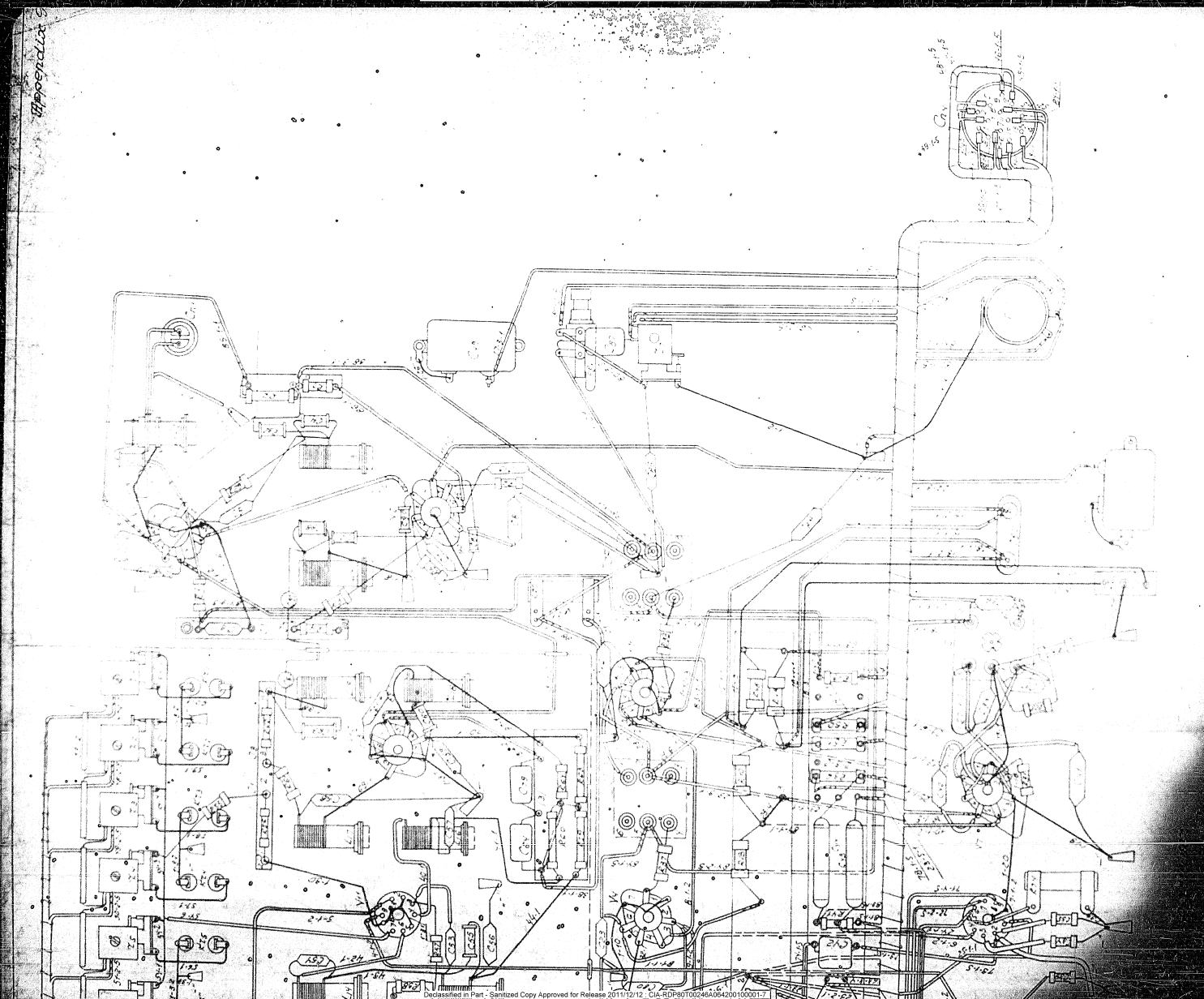

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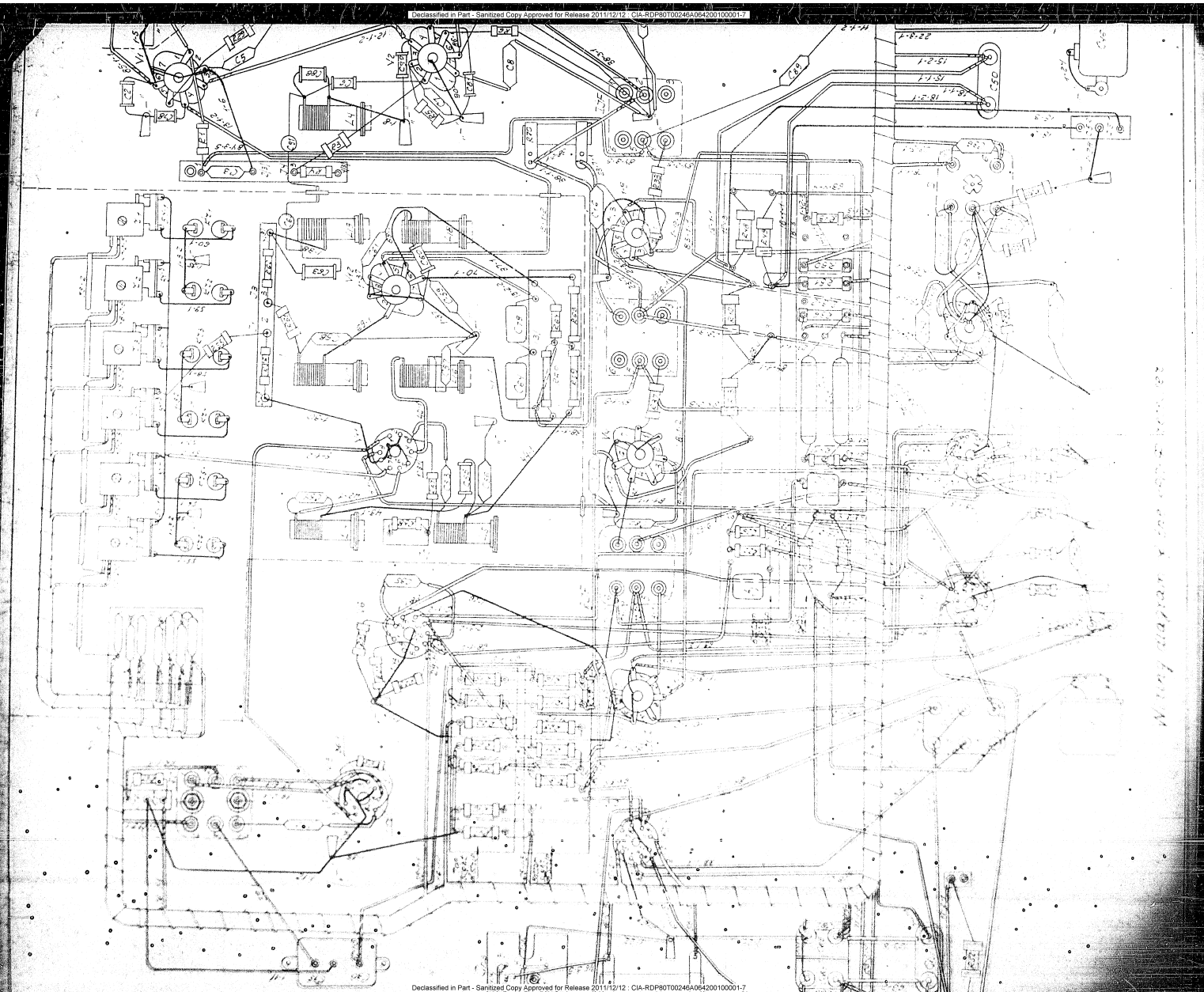

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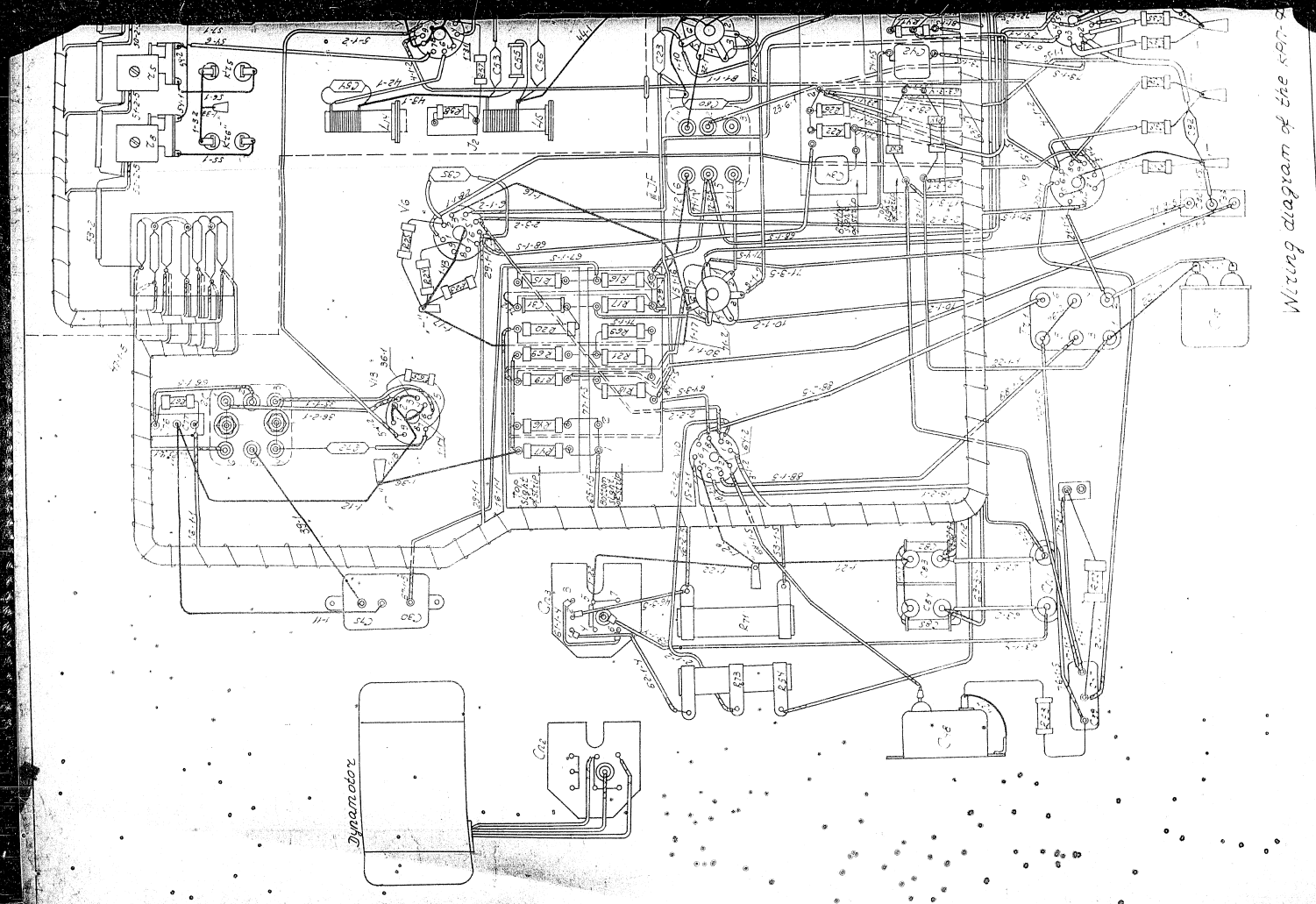

Wiring diagram of the set

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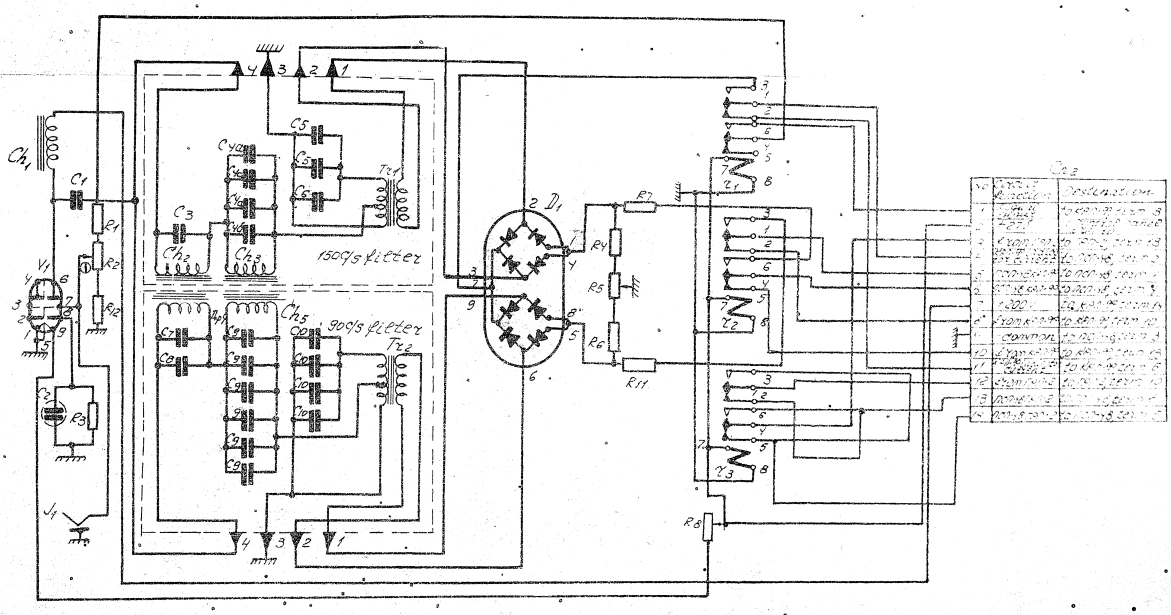

Circuit diagram of the amplitude attachment.

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Appendix 10

Appendix 11

Cn.1

Destination	Circuit function	No
to ПСП-48 term.5	ПРП-2 ПСП-48	1
to ПСП-48 term.8	ПРП-2 ПСП-48	2
to ПСП-48 term.4	ПРП-90 ПСП-48	3
		4
to attachment term.2	+27V	5
to ПСП-48 term.3	ca with	6
to ПСП-48 term.1	ПРП-90 ПСП-48	7
		8
to ПРП-90 term.2		9
to ПРП-2 term.2		10
to ПРП-2 term.7		11
to ПРП-2 term.1		12
to ПРП-90 term.7		13
to ПРП-90 term.1		14

Circuit diagram of the capacitors unit.

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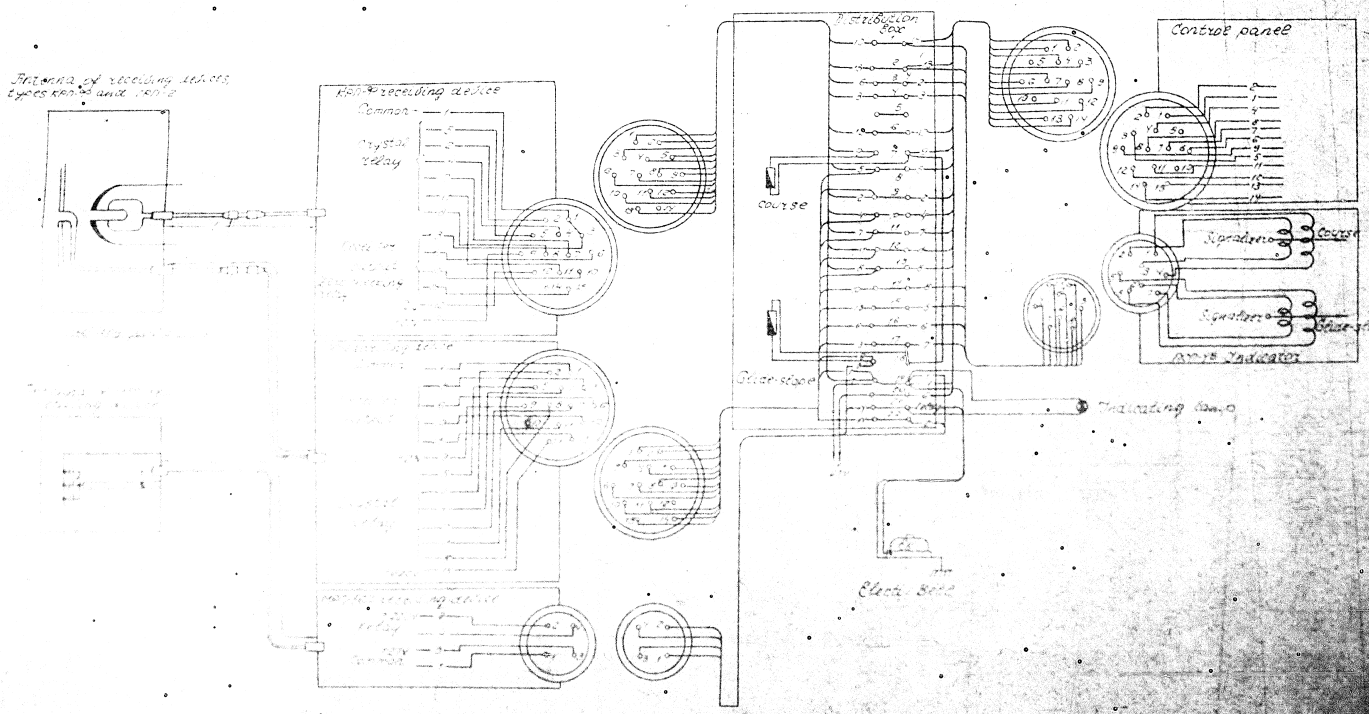

Cable connections in the "in-co system

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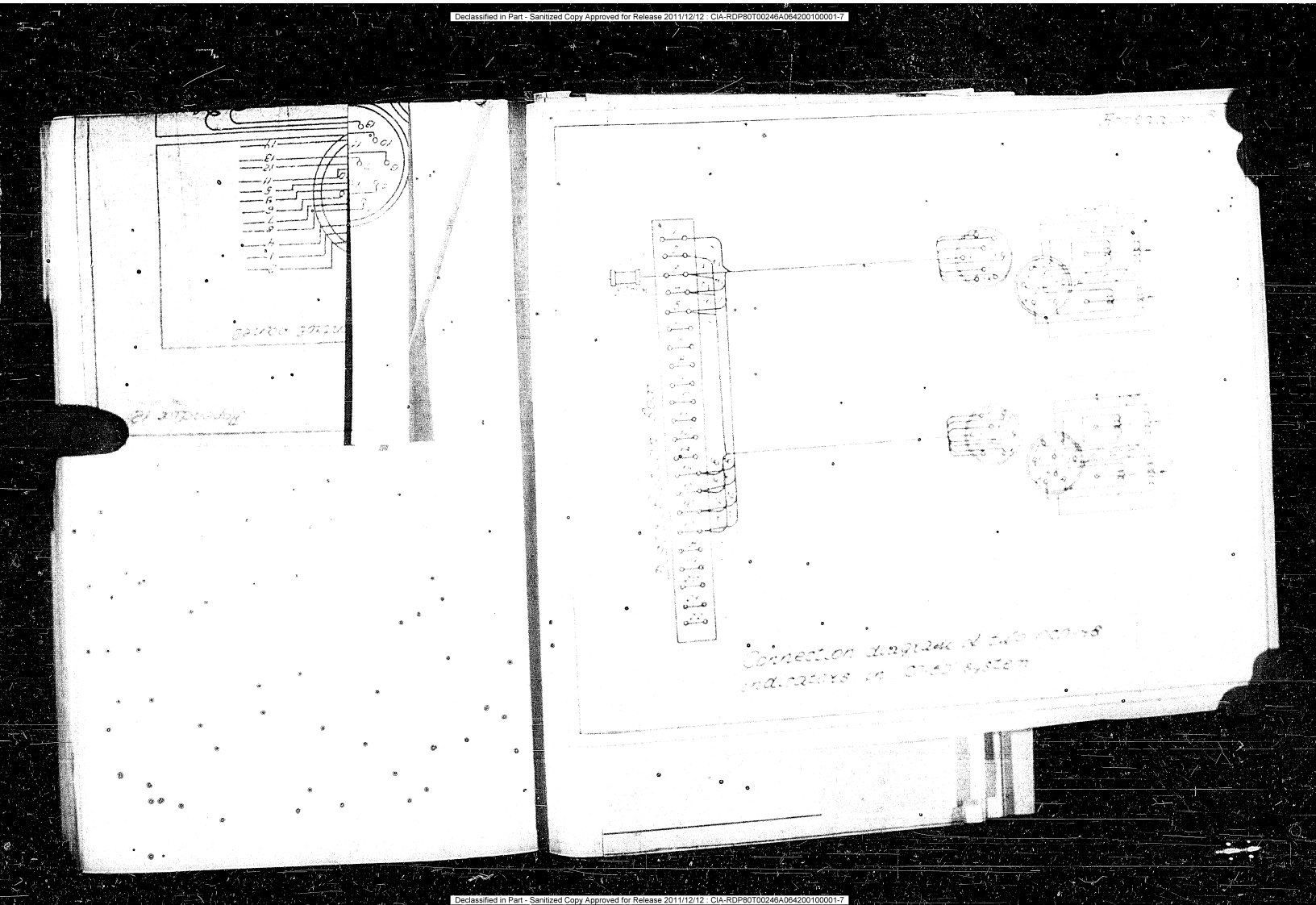

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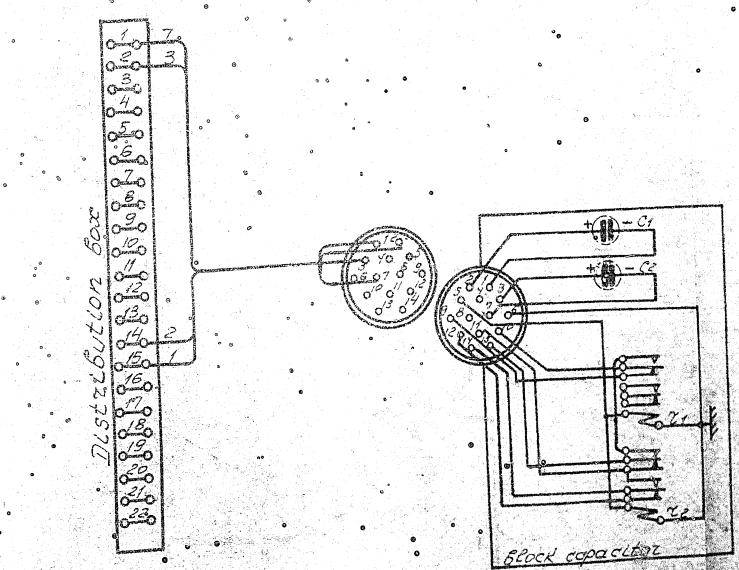

Circuit of inserting block capacitor in CN-56 "Sisten

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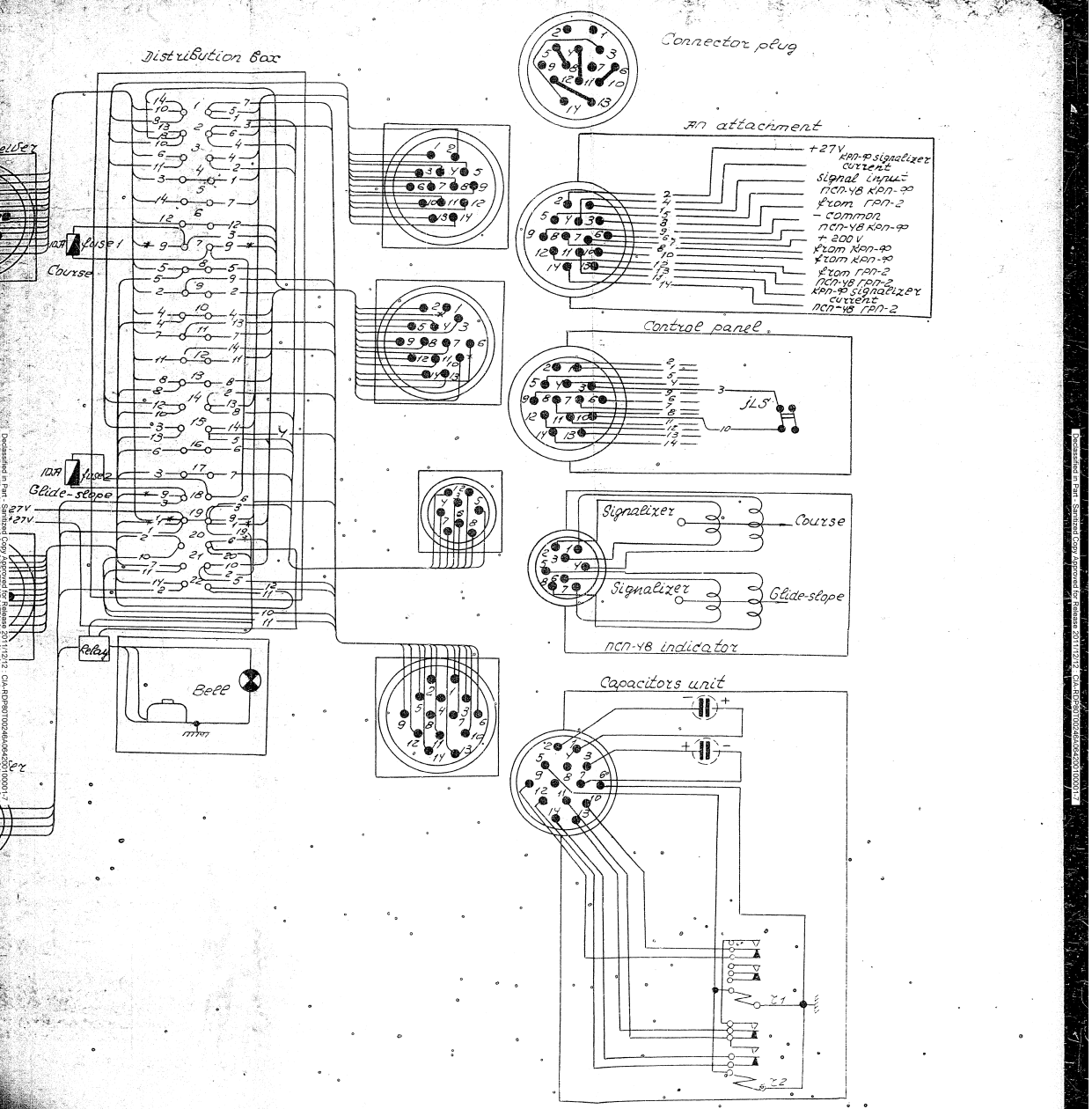

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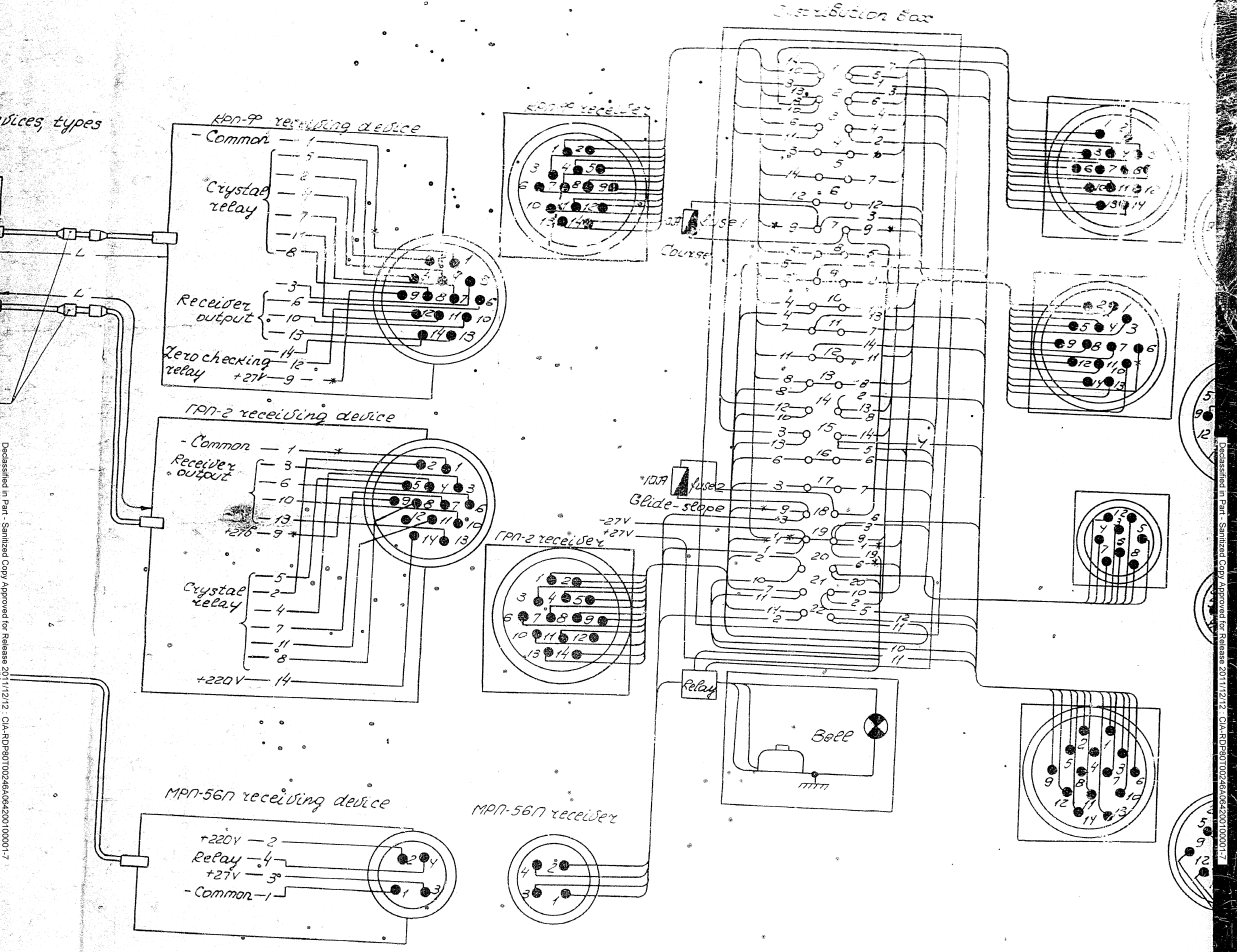

The diagram of cable connections in "СП-50" and "ILS" systems.

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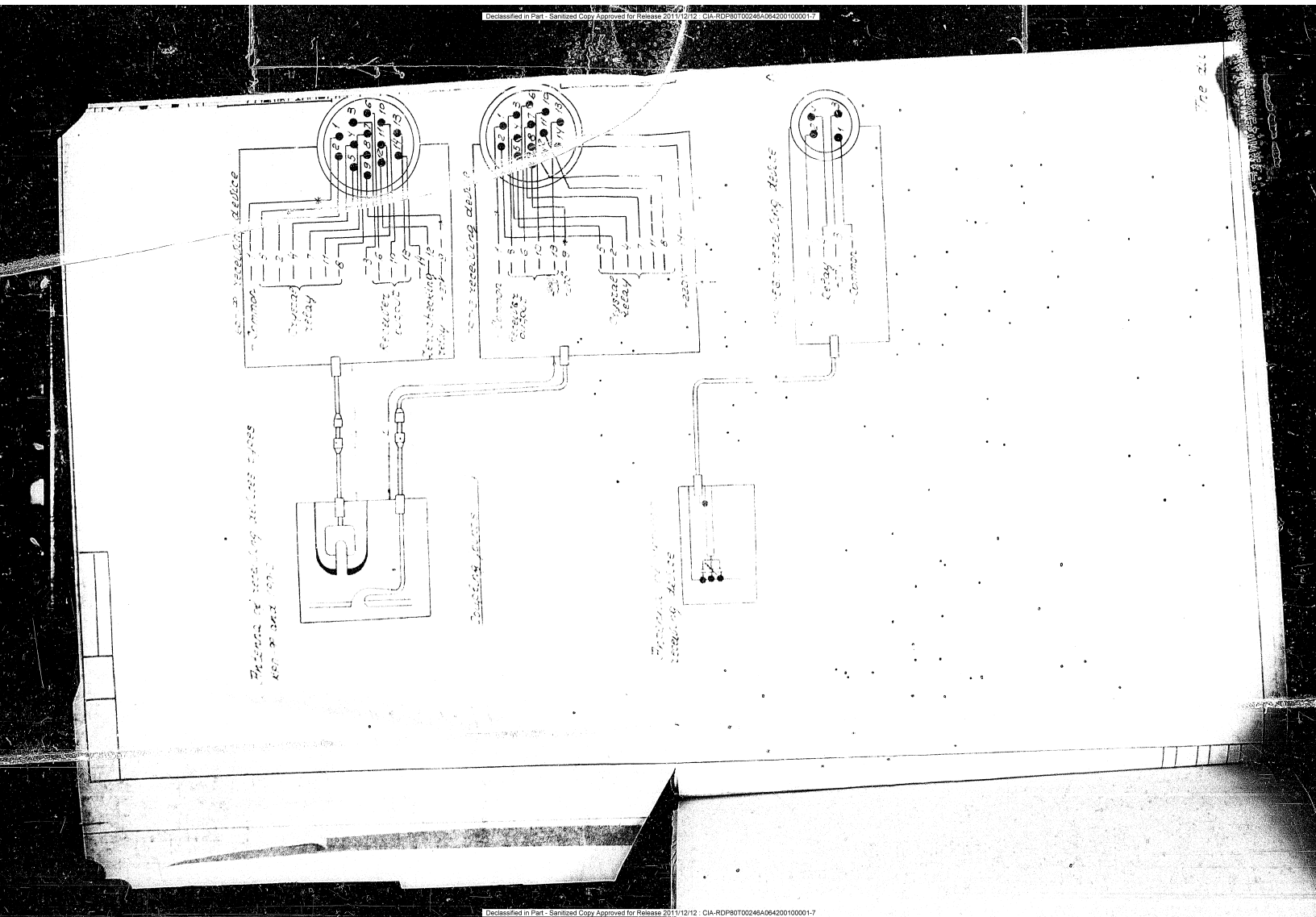

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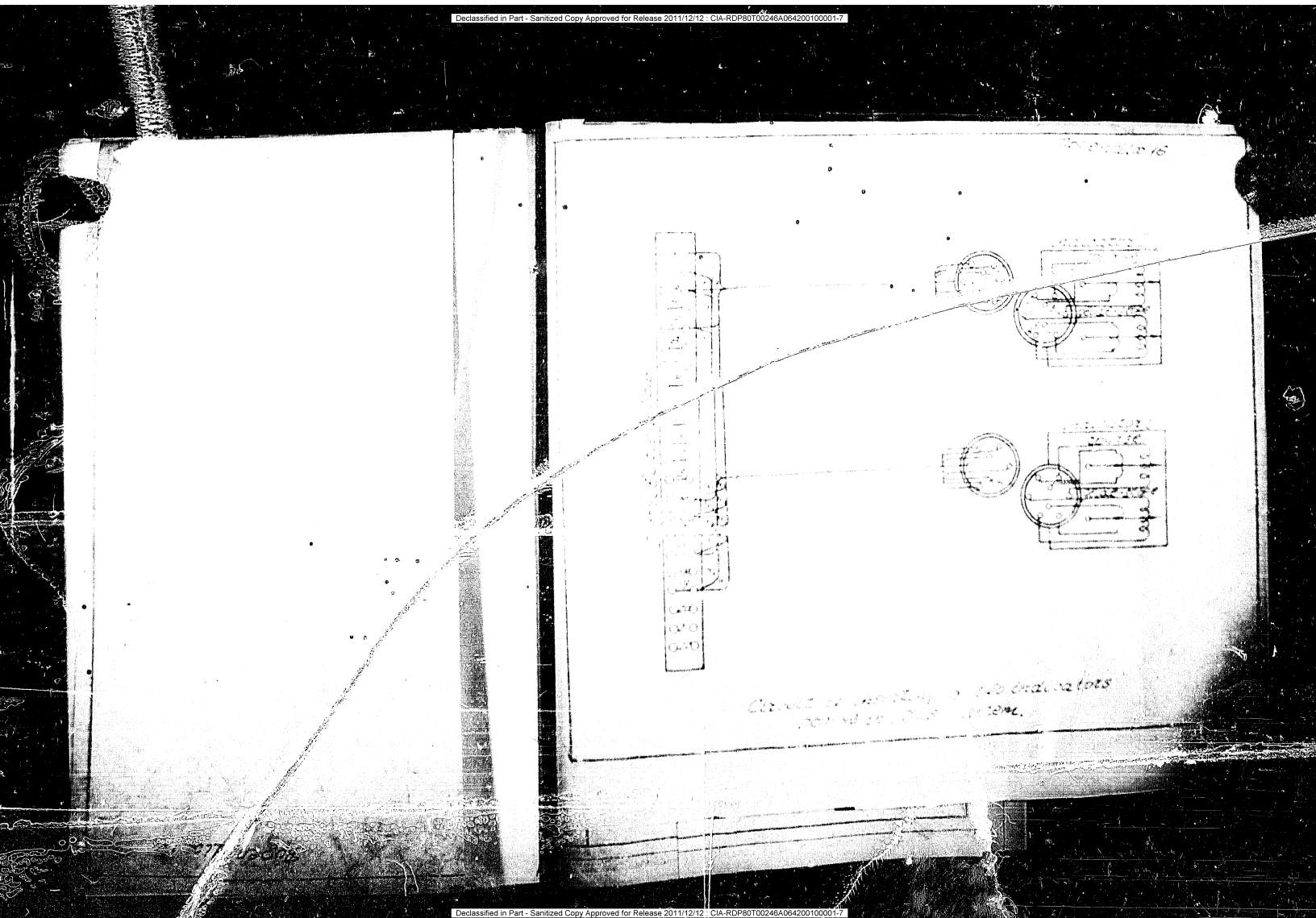

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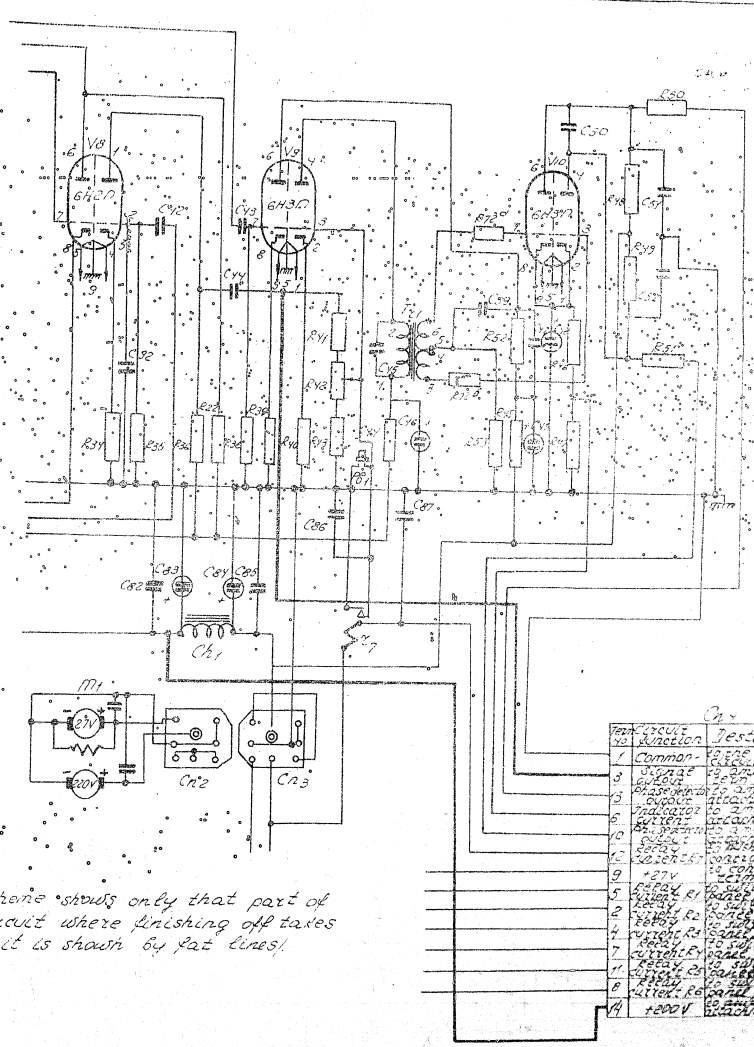

Note: The scheme shows only that part of the circuit where finishing off takes place / it is shown by fat lines /.

Ch 4

Term No	Circuit function	Destination
1	Common -	to the aircraft circuit 0
3	Signal output	to amplitude attachment term 3
13	Phase detector output	to amplitude attachment, term 10
6	Indicator current	to amplitude attachment, term 11
10	Phase detector output	to amplitude attachment term 8
12	Relay current R7	to indication on control panel
9	+27V	to control panel term 3
5	Relay current R1	to switch on control panel, term 5
2	Relay current R2	to switch on control panel, term 6
4	Relay current R3	to switch on control panel, term 7
7	Relay current R4	to switch on control panel, term 7
11	Relay current R5	to switch on control panel, term 11
8	Relay current R6	to switch on control panel, term 8
14	+200V	to amplitude attachment, term 7

Circuit diagram of modifications of KPN-90 receiver for operation in the „ILS" system.

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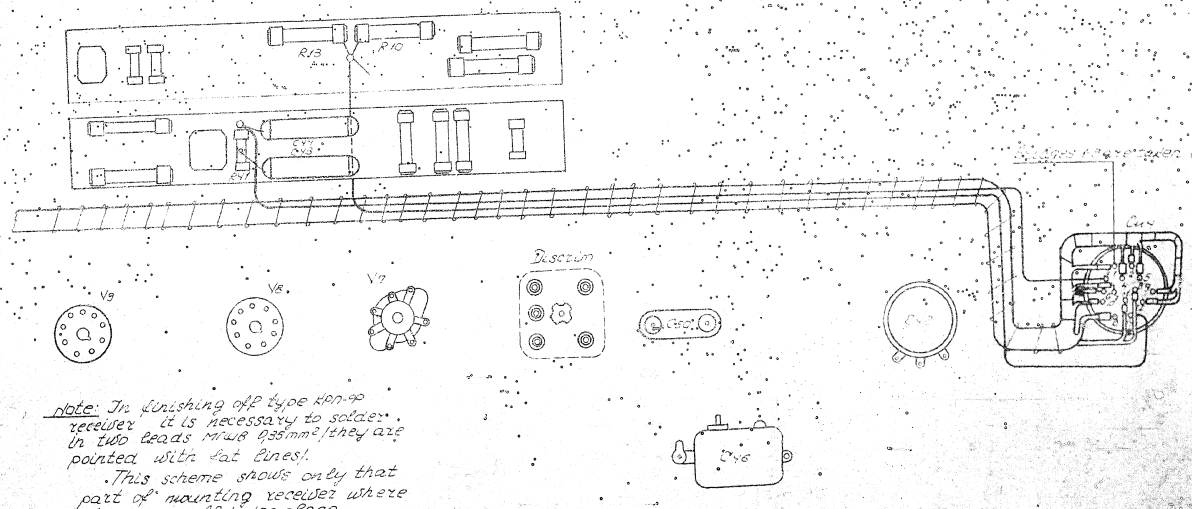

Note: In finishing off type RPN-2P receiver it is necessary to solder in two leads MGV8 0,35mm² (they are pointed with flat lines).

This scheme shows only that part of mounting receiver where finishing off takes place

Circuit diagram of modifications of the RPN-2 receiver.

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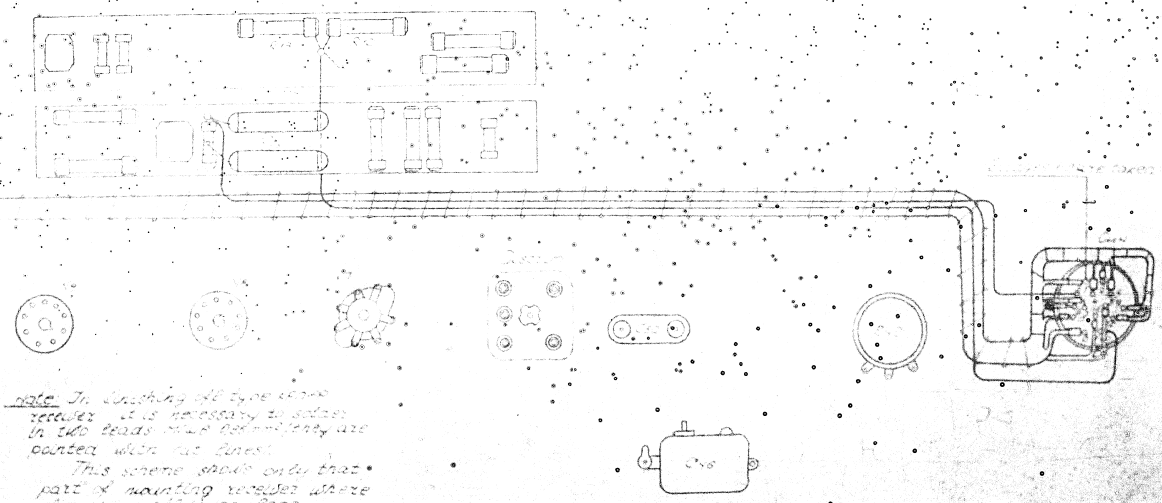

Note: In finishing off type [illegible] receiver it is necessary to solder in two leads [illegible] they are pointed with cut lines.

This scheme shows only that part of mounting receiver where finishing off takes place

Circuit diagram of modifications of the ГРП-2 receiver.

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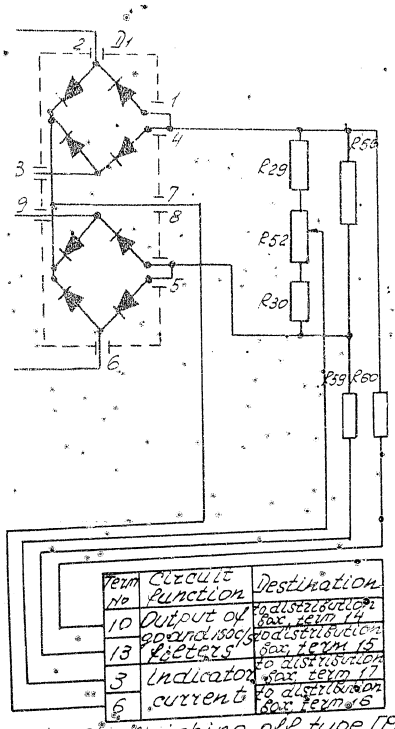
Appendix 19



Term No	Circuit function	Destination
10	Output of 90 and 150 c/s filters	to distribution box, term 14
13		to distribution box, term 15
3	Indicator current	to distribution box, term 17
6		to distribution box, term 16

Note: In finishing off type ГРП-2 receiver it is necessary to replace resistance R50-300 ohm by resistance МЛТ-0,5-680 ohm-II and to add resistances R59 and R60 МЛТ 0,5-510 ohm-II.

This scheme shows only that part where finishing off takes place.

Circuit diagram of modifications of ГРП-2 receiver.

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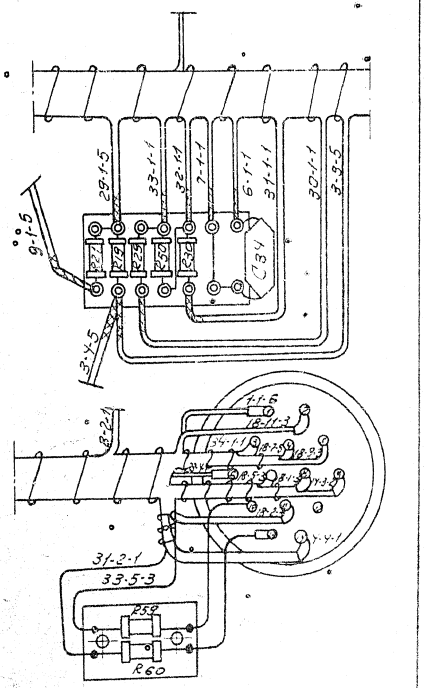
Appendix 20



Note:

1. In finishing off type RPN-2 receiver set the strip with two resistances R59, R60 MLT-0,5-510 ohm - Ω and replace resistance R50 3000hm by resistance MLT-0,5-680 ohm - Ω.
2. This scheme shows only that part where finishing off takes place.
3. The strip is secured with two screws through the holes diam. 0,35 mm on the bottom of the receiver case.

Wiring diagram of modification of the RPN-2 receiver.

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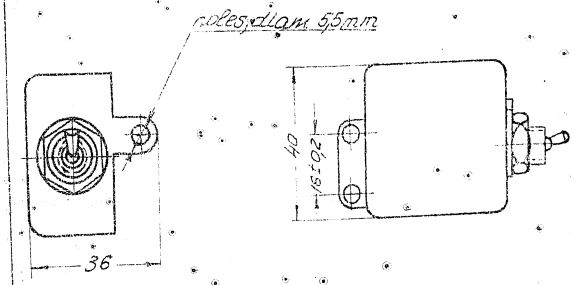
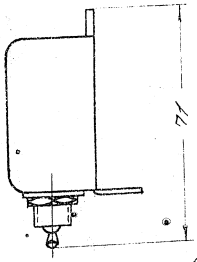
Appendix 21





Note:

dimensions of installing are painted in mm.

Switch.

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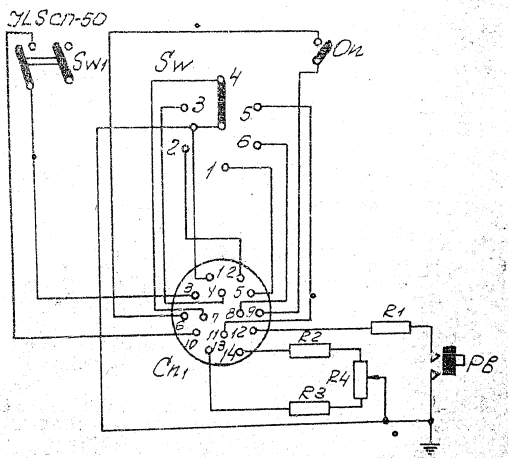
Appendix 22



Modification circuit diagram of control panel

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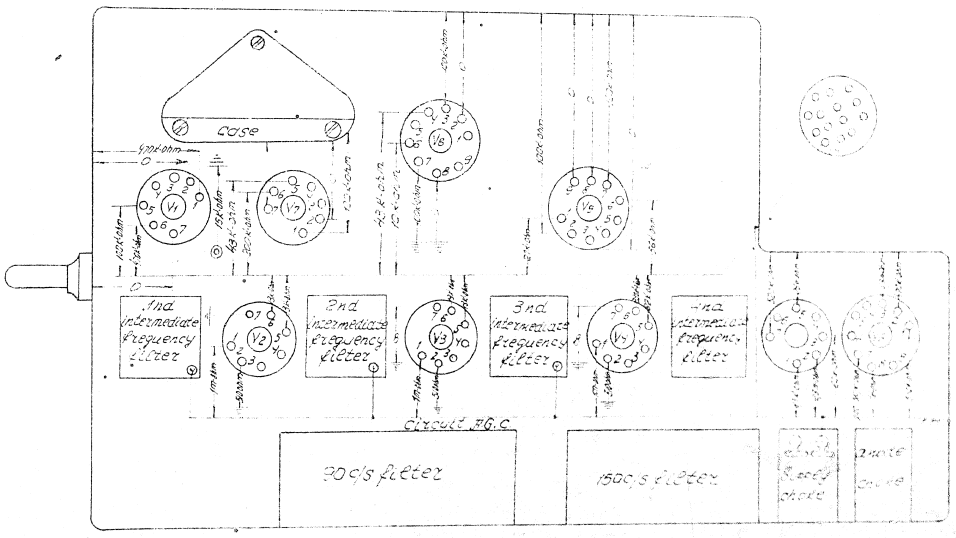
Appendix 38



Resistance chart of RAN-2 receiver

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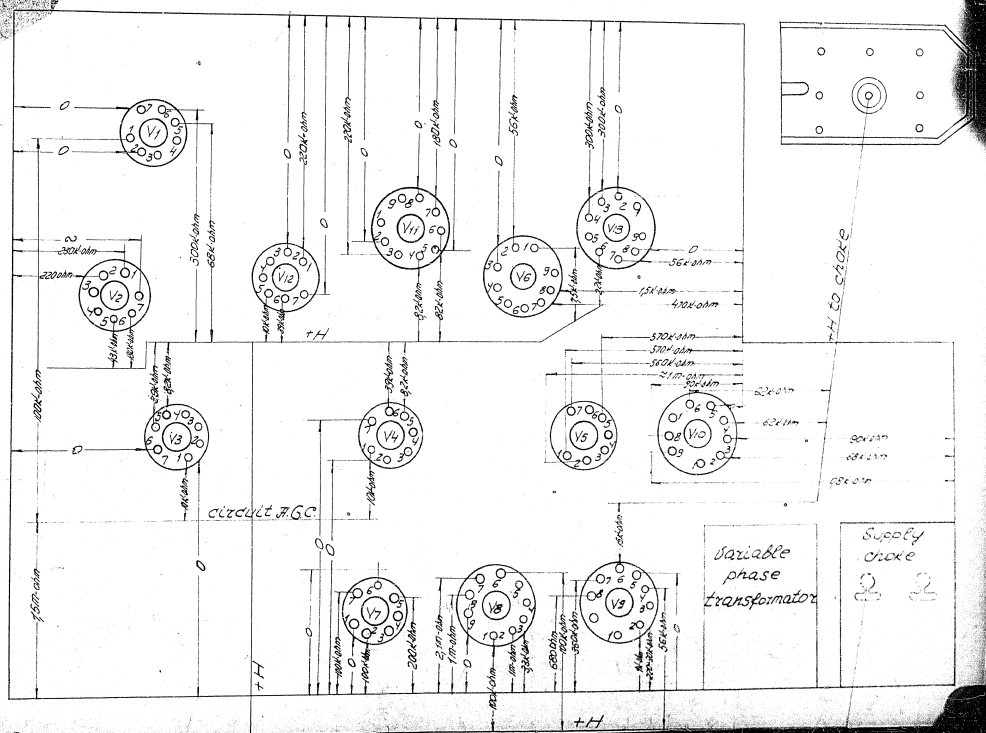

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